THE ILLUMINATING ENGINEER

LIGHT LAMPS FITTINGS AND ILLUMINATION

THE JOURNAL OF GOOD LIGHTING

OIL GAS ELECTRICITY ACETYLENE PETROL-AIR GAS ETC.

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Light and Industry

OF all applications of artificial light there is none that offers a more promising field for the skill of the illuminating engineer than the factory. On p. 282 we are summarizing the Report of H.M. Chief Inspector of Factories for the past year. It will be observed that the total number of registered factories and workshops now exceeds 250,000. Attention is drawn to the tendency towards mass production in large and highly organized establishments, and everyone will recognize that illumination must play a considerable part in facilitating this great volume of skilled work. From the tabular data on accidents in factories, issued as an appendix to this report, we see that during 1927 the total number of accidents in factories and workshops of all kinds reached the huge total of 156,974, of which 973 were fatal. Here again it requires little imagination to visualize the possible benefits of better lighting. If all these 250,000 factories and workshops were properly lighted the economic benefit in reduction of accidents and improvement in efficiency would represent a huge sum, and the national benefit would surely be so substantial as to far outweigh the expenditure incurred.

Readers of this journal have had ample opportunities of tracing, during past years, the progressive development of interest in factory lighting in this country. An outstanding event was the appointment of the Home Office Departmental Committee on Lighting in Factories and Workshops shortly before the war. The three comprehensive reports issued in 1915, 1921 and 1922 excited great interest both at home and in other countries, and have done much to create a general understanding of the importance of good industrial lighting and the best methods of obtaining it. Equally useful have been the periodical conferences with joint industrial councils on the requirements of certain industries, and the valuable researches undertaken by the Illumination Research Committee, working under the Department for Scientific and Industrial Research. Due recognition should also be paid to the patient educational work of H.M. inspectors of factories. The sympathetic interest in lighting problems shown by the Home Office Factory Department has done much to create an atmosphere friendly to suggestions for improvement. Individual problems in factory lighting have likewise been the subject of discussion at meetings of the Illuminating Engineering Society, which has been linked to all these various efforts to establish the claims of better lighting. All these efforts have been supplemented by the propaganda of leading firms in the lighting industry, conducted on highly enterprising lines, to which a reference is made in the Chief Inspector's report for the past year.

Much valuable pioneering work has thus been done. It is not too much to say that managers of of factories and workers have now a much keener appreciation of the value of good lighting in their common interest. Successive reports of H.M. Chief Inspector of Factories have commented on the progressive improvement in conditions of illumination during recent years, though admittedly many instances of bad lighting still exist and much educational work remains to be done.

In general, defects arise not through unwillingness to make improvements, but through sheer lack of knowledge of the fundamental requirements. Naturally, the task of influencing the 250,000 factories and workshops in this country is a stupendous one. An enterprising effort in this direction, planned by the Electric Lamp Manufacturers' Association of Great Britain Ltd., and conducted by the British Electrical Development Association, is now in progress. We give elsewhere some particulars of this campaign, which includes the issue of five successive letters and educational leaflets to over 100,000 factories and workshops. Those responsible have wisely confined themselves to emphasizing fundamental rules of good lighting, and to presenting the benefits of good illumination in simple but vigorous terms. (The series of ten "Facts" illustrated by pictures in one of the leaflets is well conceived.)

The first aim in all such propaganda must be to kindle interest. Next comes the outlining of broad principles of good lighting. Finally, we come to the more detailed work involved in the study of the requirements of certain processes and industries, and the collection of data showing the actual results of improved methods of lighting. Naturally, leading firms in the lighting industry will aim at the standardization of methods of equipment. It is, indeed, surprising how much can be done to meet the needs of widely different industries by methods conceived on broad and general lines. But experts are well aware that each industry—one might, indeed, say each factory—has problems of its own, and that the ideal lighting conditions can only be determined by patient work in which the expert on lighting and the user should share.

There is a natural tendency to concentrate first on the need for sufficient illumination—and it can hardly be doubted that the great majority of factories in this country are still vastly "underlighted." But we are

glad to see that other equally important factors, such as elimination of glare and harmful shadows, are now being emphasized as well. Schedules of illumination values for various processes are at present based on practical experience, and may be regarded as representing roughly what is commonly termed "good practice." But for most industries the scientific basis underlying the fixing of such values, in relation to production has yet to be determined. Ultimately, in all such researches, we come back to the requirements of the human eye, and in this connection we should like to draw attention to the instructive paper by Mr. Schneider, which commences in the present number. (See p. 275.) A feature in this contribution is the distinction drawn between processes which involve simply acuteness of vision and those into which speed of perception, mental response and other elements enter. It is now recognized that the familiar simple tests based on the observation of Snellen test charts illustrate only a small part of the performance of the eye and the brain in many many industrial processes, and that "maximum efficiency" may require widely different intensities of illumination.

Science and Craftsmanship

THE annual meeting of the British Association is almost invariably the occasion of the presentation of certain aspects of science which capture the public imagination. The present gathering in Glasgow has been no exception. There have been numerous contributions, notably that of Professor Donnan, summarizing some recent physiological discoveries of Dr. Leonard Hill, which have aroused interest. But the dominant item was undoubtedly the Presidential Address of Sir William Bragg, reviewing the relation of science to industry.

Sir William gave many instances of the great gifts bestowed by science and of the intimate part which it plays in all forms of "craftsmanship." This term should no longer be interpreted to mean merely manual dexterity and skill, but rather the application of science in the service of mankind. The discoveries of such men as James Watt and Michael Faraday have gradually resulted in the development of new tools and appliances, and have engendered new forms of craftsmanship. The motor industry, the navigation of the air, and the vast development of artificial silk are other instances of industries which are the result of scientific discovery.

Sir William struck an inspiring note in his analysis of the efforts of the craftsman to whom the performance of his work comes before the hope of reward. In the concluding portion of his address he referred to the "riddle of light," and to the long-standing problem whether light is the result of movements of waves or of minute particles.

Behind the work of the illuminating engineer—surely an example of craftsmanship in its best sense—there rests an ultimate scientific background. We who utilize light in the service of mankind have still a very imperfect conception of the process from which this light is derived. It may be that a fuller knowledge of these complex processes will ultimately furnish us with means of providing light having a degree of flexibility and efficiency undreamed of to-day. Meantime our methods of applying light improve year by year. We have, too, in our work a human touch which is not present in the same degree in most other fields of engineering. For the judgment of our work depends on the perception of the human eye and the understanding of the human brain; and in applying each new development we must call into counsel not only those who create these new tools but those who use them.

Public Lighting

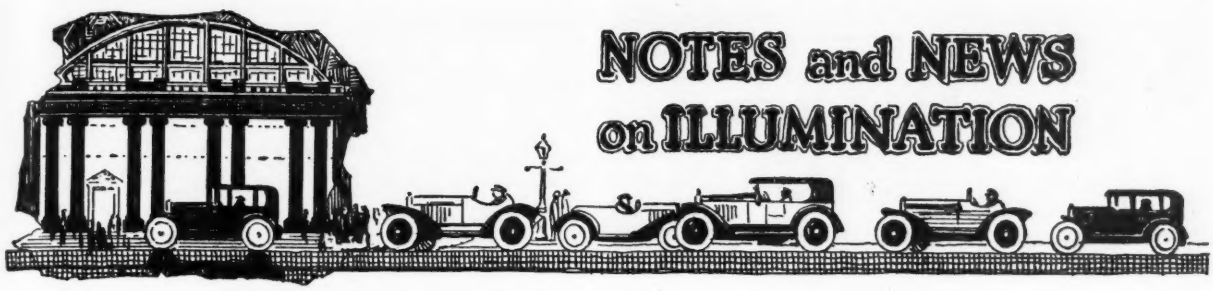
The Compromise Between Uniformity of Illumination and Glare

FROM several quarters we have received comments on the note on public lighting in our last issue (p. 247), which seems to have excited a considerable amount of interest. The problem of street lighting resembles the design of automobile headlights in that apparently conflicting principles are involved, and at present a compromise seems the best solution. This is specially evident when one considers the question of securing a certain minimum illumination, which is most economically obtained with a low "diversity factor." We believe that on general grounds it is still desirable that illumination should be spread evenly over the surface of a street, although in certain cases, e.g., at important street intersections, extra illumination may well be provided. In street lighting, as in other lighting problems, *scientific direction of light* still remains the fundamental aim of designers.

The only question is whether, in some instances, extreme uniformity of illumination may not involve undue sacrifice in another direction, i.e., by causing glare. With lighting units spaced widely apart undue accentuation of the candle-power at angles slightly below the horizontal may result in a considerable degree of dazzle. This applies particularly to cases where the light comes from a relatively small source and the intrinsic brilliancy is high; doubtless when the light can be spread over a diffusing lantern of considerable area the effect is less acute. This consideration favours the use of diffusing media, which we expect to play an even more important part in the public lighting of the future. In considering this question due regard must be paid to the nature and functions of a street. In some cases general appearance may be quite as important as scientific distribution of light, and the latter may occasionally have to be modified for the sake of securing a pleasing effect.

Another debatable point is the method by which good visibility is best secured and the influence of the "silhouette effect." It is admitted that with shiny road surfaces in a wet condition the apparent distribution of brightness on the roadway may depart widely from the curve of illumination. Yet this fact does not justify one in disregarding the degree of uniformity of illumination; all road surfaces are not highly polished, and irregular distribution of illumination is in itself no guarantee of uniform brightness. The efficacy of "vision by silhouette" depends on the reflected streaks of light in the roadway. Clearly this furnishes another reason for careful selection of the positions of points, and also an inducement to utilize diffusing surfaces in lanterns so that the bands of reflected light are broader and the possibility of glare from reflected images of light sources is diminished.

Finally, whilst it may be admitted that "vision by silhouette" at present plays a considerable part, we do not think that the degree of visibility thus secured can be compared with that attainable by the methods adopted in good interior lighting. The ultimate aim in street lighting should be to secure that objects are illuminated by the aid of light coming from all directions, so that not only their outlines but their general shape and dimensions may be clearly revealed.



Illuminating Engineering Society

OPENING MEETING.

The opening meeting of the Illuminating Engineering Society will be held at the E.L.M.A. Lighting Service Bureau (15, Savoy Street, Strand, London, W.C.2), on the evening of *Tuesday, November 6th.* As usual, this opening meeting will be devoted to reports of progress and the exhibition of novelties. There will be the usual review of progress during the vacation, and reports of progress in gas and electric lighting. It is also hoped that Mr. C. C. Paterson, the new President, will give an address dealing with the International Illumination Congress held last month in the U.S.A.

This opening meeting furnishes an opportunity for the display of any new and interesting types of fittings, luminous devices, photometers, etc., and any members who are prepared to make exhibits of this kind are invited to communicate with the Hon. Secretary (Mr. J. S. Dow, 32, Victoria Street, London, S.W.1).

Special Meetings in the Provinces

As announced in our August issue, a new departure is being made this year by the holding of a series of meetings in provincial cities, which will be devoted to discussions on industrial lighting. It is proposed at each meeting for a short introductory address to be delivered by some member of the Illuminating Engineering Society. We understand that Mr. D. R. Wilson (President, 1927–28) has kindly consented to deliver the address at the opening meeting in Birmingham. Mr. J. L. H. Cooper's paper, entitled "An Investigation of Electric Lighting in the Engineering Industry," will then be read. Mr. R. Chattock, M.I.E.E. (City Electrical Engineer, Birmingham), has kindly consented to preside at the first of the series in Birmingham, Professor Magnus McLean will take the chair at the meeting in Glasgow, and Mr. P. P. Wheelwright at Manchester. As we go to press we learn with pleasure that Sir Charles Parsons has consented to preside at the meeting in Newcastle.

We are asked to mention that the Hon. Secretary would be glad to hear from members of the Society who are able to attend any of these meetings, the dates of which are set out below. Members are also asked to send in the names of any people in these areas likely to be interested in industrial lighting, to whom invitations to be present at meetings might be sent.

The provisional list of meetings is as follows:—

Date. Time.	Place of Meeting.
BIRMINGHAM—	
Oct. 22—7- 0 p.m.....	Hall of Chamber of Commerce, Birmingham.
MANCHESTER—	
Oct. 29—7- 0 p.m.....	Electric Lighting Service Bureau, 4, Fountain Street, Manchester.
NEWCASTLE—	
Oct. 31—7-15 p.m.....	North East Coast Lighting Service Bureau, "Dial House," Northumberland Street, Newcastle-on-Tyne.
GLASGOW—	
Nov. 1—7-30 p.m.....	Central Halls, 25, Bath Street, Glasgow.

Rates and Illuminated Signs

We notice in *Electricity* a reference to a curious point in connection with illuminated signs. The Advertising Stations (Rating) Act permits a special rate to be levied on public signs, and it is apparently assumed that the trader receives some payment for the site from the advertiser. But what if he receives none? This point was raised in a recent test case in which a trader had allowed one of his supply houses to be used to put a large sign on a side wall, but no money had passed. The local rating authority sought to increase his rating assessment by £4 per annum. Ultimately the proposed increase was ruled to be illegal. The final position, therefore, is that a trader may, without becoming liable for extra rates, exhibit signs, notices or posters upon any vacant site attached to his premises, provided that such matter relates to his trade and that he receives no monetary consideration in respect of it.

Bureau of Standards Journal of Research

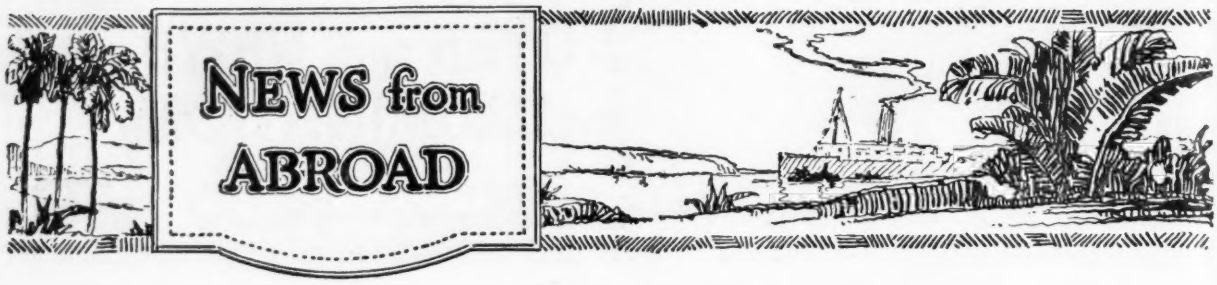
From July onwards the Bureau of Standards, Washington, has initiated a new departure, the issue of a new monthly periodical, *The British Bureau of Standards Journal of Research.* This continues the publication of the two series of research papers hitherto issued, and also contains critical reviews in the fields of science and technology. It is hoped that this step will tend to bridge the gap between pure and applied science and to shorten the lag between discovery and its application. Readers will note with interest this development in the excellent work of the Bureau of Standards, which freely places at the service of scientists in all countries the results of many important scientific investigations.

Sir Hugo Hirst leaves for Australia

A large number of friends gathered at Victoria Station on August 30th to wish *bon voyage* to Sir Hugo Hirst, the chairman of directors of the General Electric Co. Ltd., who formed one of the Government mission appointed to confer with the Commonwealth Government and leading leaders of industry in Australia regarding the development of the resources of that country and the promotion of trade with Great Britain. We feel sure that Sir Hugo's great experience will prove most valuable to the mission, and everyone will recognize that he is doing a great public service in undertaking this onerous work. Readers will join us in wishing him "God-speed" and a safe return.

Training in Salesmanship and Engineering

An interesting recent announcement has been the acceptance by Mr. F. W. Goodenough and Sir Dugald Clerk of the chairmanships of the committees on training in salesmanship and engineering, initiated by the Board of Education. Mr. Goodenough's name is, of course, familiar to all readers of this journal as one of the leading figures of the gas industry, who has taken a great interest in the work of the Illuminating Engineering Society, and has served on its Council from its early stages onwards. Mr. Goodenough has also been responsible for much pioneering work in promoting the training and welfare of those entering the gas industry, and he is one of the recognized authorities on salesmanship in this country. We feel sure that no better choice could have been made and that his guidance as chairman will be of great benefit to the committee.



Illuminating Engineering Society, U.S.A.

TWENTY-SECOND ANNUAL CONVENTION.

We have now received particulars of the papers arranged for the above convention, which took place in Toronto during September 17th–20th. As usual, the series was contrived on enterprising lines, special sessions being devoted to natural lighting, lighting practice, etc. The former included an account by Dr. Walsh of Illumination Research at the National Physical Laboratory, and an address was given by Mr. C. C. Paterson. Other subjects include the operation of gaseous tube signs, the advertising value of mobile colour lighting, bank lighting, and the effect of ultra-violet light on window materials—the latter a problem on which definite data will certainly be welcome. A new departure was the arrangement of a European Lighting Session. Mr. C. A. Atherton and Mr. W. E. Bush dealt with lighting developments in Europe, whilst Dr. M. O. Bausenwein was responsible for a paper with a highly interesting title, "Methods of Lighting Promotion adapted to Economically Weak Nations." In the final session Mr. Preston S. Millar contributed a paper dealing with street surfaces as a factor in street lighting, and a report by the Motor Vehicle Committee was presented. A somewhat unusual problem—the illumination of endless caverns—was dealt with by Mr. W. A. Oglesby. This series of papers should make interesting reading.

Combined Street and Flood Lighting

A novel type of street-lighting fitting, designed to combine ordinary public lighting with floodlighting of certain buildings, has been introduced by the Public Service Electric & Gas Co., of Newark, N.J. The lanterns, as illustrated in *The Electrical World*, contain two units. There is a floodlighting reflector which is capable of vertical adjustment, displacement horizontally being effected by the rotation of the lantern as a whole. These floodlighting units may contain lamps of 500–1,500 watts. There is also an upright 200-watt lamp which serves for ordinary purposes of illumination. The glass panels of the lantern on the side facing the building to be floodlighted are of clear glass; those facing the street are of diffusing glass, so that from the roadway the composite nature of the unit is not apparent. Posts equipped with these units are mounted at spots where it is desired to floodlight certain buildings. No doubt the diffused reflected light from the surfaces of such buildings furnishes a useful supplement to the ordinary public lighting.

Luminous Traffic Signals in Germany

The system of traffic control by means of luminous signals, which has proved so successful in the United States, and is now being experimented with in some cities in this country, is also being adopted in several German cities, notably Berlin and Leipzig. The signals are worked on the now familiar "three-colour" system, the coloured bull's-eyes being equipped with shields in the same manner as those used in the United States. Two main types are found, one a pendent unit commonly suspended on wires crossing the street, the other arranged in the form of columns mounted on the pavement. In some cases the system is automatically controlled by the police, the sequence of operations being determined at the central control station. In other cases, where the traffic is less regular, the signals are operated by a police officer on the spot. It is possible that this latter form of device will prove most acceptable in this country. Complete automatic signalling has the obvious economy of relieving the police officer from point duty, but is not universally applicable; yet it requires little imagination to understand the fatigue involved in signalling with the arms for hours on end, and, whether officers directing traffic on the spot can be dispensed with or not, we anticipate that signalling by light, in place of the fatiguing and not always intelligible signalling with the arms, will tend to become more and more widely used.

Progress in Lighting in the East

An account of the progress of the British Municipal Council of Tientsin in a recent issue of *The Electrical Review* makes interesting reading. The original capital outlay was £18.9 per kilowatt of plant, and the cost of the generating plant was only £13.8, which, our contemporary remarks, is probably a record. During the past year the energy sold increased by 30.6 per cent. and the number of consumers by 29.2 per cent. This is very rapid progress, and illustrates the potentialities of the east as a user of electric light. It is also stated that public lighting increased by 21 per cent. An enterprising step has been the popularization of the electric clock.

The "News from India" from the correspondent of the Electrical Industries, to whose contributions we recently referred, points out that there is a great field for shop lighting in India. Indian shopkeepers are usually strong believers in the value of light for advertising purposes, and their premises are frequently kept open until a late hour at night. On the other hand, European shops, which would ordinarily serve as a model in regard to lighting, are generally closed at sunset. Hence it is up to local supply undertakings and agents of manufacturers to demonstrate to the Indians the full benefits of modern methods of shop lighting.

Artificial Windows

We have previously commented on the tendency, strongly represented in French practice, to adopt extensive surfaces of mild luminosity for the lighting of interiors. The "artificial window" is gaining in popularity, especially in rooms which are normally badly served in regard to daylight. Such cases are common in Chicago, and the Commonwealth Edison Company have accordingly designed a portable electric window which may be sold complete, ready to plug in to a convenient outlet. A number of such windows have already been installed in basements, and they are likely to prove particularly acceptable in restaurants and salerooms located below street level, where it is desirable to dissipate the impression of being "shut in."

The Illuminating Engineering Society in Japan

The most recently issued *Journal* of the Japanese Illuminating Engineering Society contains a contribution (in English) by A. D. Cameron, entitled "A Model State Law for Street and Highway Lighting." Mr. T. Abe deals with a new method of photographic spectrophotography, and Mr. S. Toyama describes the stage-lighting equipment of the Okuma Memorial Hall at the Waseda University. A record of recent articles on photometry and illumination in Europe is also presented.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

The Influence of Illumination on the Working Efficiency of Man*

By Dipl. Ing. L. SCHNEIDER (Berlin)

ALL occupations of mankind are influenced by light, in so far as its effect on the eye is concerned, for the eye, in registering impressions of the world around us, needs illumination. Human efforts and the working efficiency of man are likewise affected by changes in illumination.

There is a general belief that the conditions of illumination prevailing during the day are best suited for the eye, because mankind—and consequently the human eye—has developed under daylight conditions. But further consideration suggests a difficulty. It is necessary to determine the exact characteristics of good daylight illumination. The conditions of daylight illumination are continually varying. For instance, the intensities of illumination may vary from 0 to 100,000 lux†; the conditions of shadow likewise alter according to whether the light is received from the sun direct, with a clear sky, or from a cloudy sky. Finally, the influence of glare and the colour of the light deserve consideration. The fact that the eye can readily adapt itself to these, as a rule, only gradually varying conditions makes the problem of directly determining the illumination leading to the highest working efficiency difficult. Moreover, the efficiency of human work is naturally influenced by a number of external and internal factors, of which the illumination is only one. Some knowledge of all, or at least the most important, of these factors is necessary, so that they may be taken into consideration in research work on the influence of "illumination."

The importance of illumination for different working processes will naturally vary much, according to the greater or lesser share taken by the eye in the especial work under consideration. It is therefore necessary to set up a classification of the different working processes. But before doing so we should consider to what extent and within what limits the illumination can influence the efficiency, both in a physiological and psychological sense. In particular, we should seek to acertain what influence "the quality of the illumination"‡ may exercise on the functions of the eye.

The intensity of illumination (or the actual *brightness*) is of the greatest significance, as this is the fundamental element necessary before any sensation of light can arise. Glare, as an efficiency-diminishing factor, is also of vital importance. Next to glare come conditions of shadow, which contribute to all perceptions of space, and bodies involving stereoscopical vision must be considered; although we are here already conscious of the difficulty in distinguishing between physiological and psychological effects. The colour of the light is for the present of lesser interest, because of the relatively small difference existing between the colour of artificial light and that of daylight—a few special cases excepted—so that only a slight influence on efficiency might be expected from this factor. The colour of daylight is assumed to be that most favourable to the efficiency of the eye, for the reason that the eye has been developed under its influence. Moreover, our means of testing small increases in efficiency, such as might be expected, are not yet sufficiently sensitive to ensure satisfactory results. Hence it is expedient to consider, first, factors that have the most marked influence on efficiency of work.

The most important problem which has already interested scientists is the question of adequate illuminating intensities. Cohn, as one of the first investigators in this field, based his tests on the observation of acuity of vision. These and several similar tests have been undertaken for quite a number of years, and they were generally regarded as a suitable basis for determining the illumination necessary for different kinds of work. The necessary intensities ascertained in these tests naturally varied, and were found to range somewhere between 10 and 50 lux (about 0.8 to 4.2 foot-candles). Such intensities were deemed high enough, chiefly because they represented a vast advance on those prevailing in the early "very dark" epoch of candle and kerosene lamp lighting. But such illuminations no longer sufficed once mankind had found ways and means not only of improving the efficiency of machinery but also of introducing more favourable and rational working conditions.

It will also be found, in the not very extensive literature on illuminating engineering, that the demand for illumination has been continually on the increase. This increase has hitherto been mainly the result of conjecture. It was not based on positive scientific research work; indeed the results of the tests of acuity of vision mentioned above were opposed to experiences in actual practice, where higher illuminating intensities were soon found necessary. The explanation of this apparent contradiction is to be found in a misinterpretation of the importance of the acuity of vision.

Acuity of vision is, in reality, a purely mathematical definition of a special case of form sensibility of the eye. It is a definition of great value to the ophthalmologist, and as a basis for the study of errors of refraction and their correction. But it cannot be regarded as an ideal "efficiency test," because the demands of daily life to which the eye is continually subjected are highly diversified and complex, whereas the process of recognition of a letter on a Snellen chart, or a Landolt's ring in the acuity of vision tests, is simplicity itself. The objects used in these tests of vision are of the simplest form, even as compared with

* Abstract of a paper read before the German Illuminating Engineering Society, Hamburg, 1927.

† 10 lux are roughly equivalent to 1 foot-candle.

‡ Teichmüller: *Licht und Lampe*, 526, 1924.

handwritten or typewritten material. Again, a contrast between letters having a reflection coefficient of 2 to 4 per cent. on white paper with a reflecting coefficient of 60 to 70 per cent. is usual in printed text; but this does not apply to typewritten letters or writing in pencil, and much less so to objects in general as viewed in the world around us. Furthermore, there is also the time element to be considered. In ordinary tests of acuteness of vision no restriction is placed on the time available for distinguishing each single test object; whereas, for instance, in reading print the eye must fly from one group of letters to another or from word to word in a jerky kind of manner, so that it has only a certain shortest time for picking up details. How much more difficult must it therefore be to recognize objects that pass through the field of vision at a high speed!

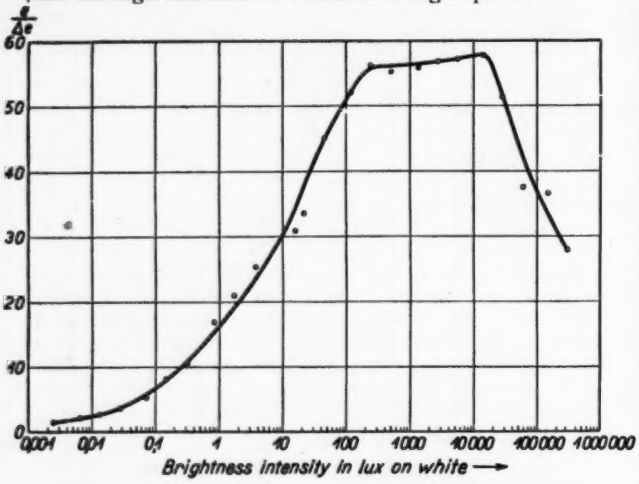


FIG. 1.—Sensitivity of the Eye to Brightness Difference.

An attempt has been made to meet this difficulty with the aid of psychotechnics. After a few unsatisfactory simple psychological and ophthalmological investigations, it was decided to reproduce conditions more closely resembling those of actual life. The psychotechnics of objects treats " of the practical adaptation of the world around us to the special physiological and psychological qualities of the complex ' man '." The psychotechnical tests that have already been undertaken on a large scale for determining the influence of illumination on the working capacity of mankind usually resulted in much higher illuminating intensities for certain categories of work. Naturally, the results of all such studies greatly depend on the particular test method adopted, and it is not to be wondered at that such tests now and then give results that appear to be exceptionally high or low. This is easily explicable if one considers, firstly, that the test method adopted may have taxed the functions of the eye too heavily, or, when altering any one of the coefficients, the others, in ignorance of their importance, were not held constant. This, for instance, might be the case, if the illumination intensity should be varied without considering that the conditions of shadow might likewise be varied.

Such considerations, however, do not imply that psychotechnical methods should not be adopted for ascertaining the effect of illumination. On the contrary, psychotechnics may furnish a basis for scientific investigations of light, just as photometry has already done before*. But these methods of test will only give truly satisfactory results when the gap still existing to-day between the ophthalmological tests of visional acuity and the methods of testing psychotechnical efficiency has been bridged by the aid of physiology and psychology.

An attempt will now be made to build the physiological part of the bridge, the physiological aspect being the more important because it represents the first step from our actual surroundings to our centres of perception (in so far as it is possible to distinguish sharply between physiology and psychology). The perception of an object is effected by a number of " fundamental sensations " of the eye. The most simple of these is the faculty of discerning differences in brightness as such. The eye's most highly developed sense is the ability to distinguish between slightly different degrees of brightness. The second step is its aptitude of discriminating between *shapes* of slightly different brightnesses, e.g., the shape of a black letter on a white paper. This is the so-called " shape sensitivity." Acuity of vision should also be classed as a special case of this function. A third very important factor is the necessary " time of sensitivity," that is, the time that must elapse before the retinal impression is realized in the brain. It is only possible to speak of an efficiency after a record of the time necessary for the sensational impression to take place has also been made. Its combination with the discriminating sensitivity gives the limit—or threshold—values for stimuli of short duration, and their combination with the " shape sensitivity " gives right to the so-called " speed of perception," i.e., the threshold time that is needed for the eye to be just able to distinguish clearly the contrast of a given form.

In considering these impressions and their application to the normal processes of the eye, we have assumed that normal conditions prevailed. This implies natural accommodation and conditions of adaptation. These two processes take place in a natural and uninfluenced manner, so that to alter them artificially would cause disturbing compulsory conditions, and it would afterwards be very difficult to bring these purposely altered conditions back to the normal again. In this connection we might here mention the research work of König and Brodhun on threshold brightness and discrimination sensitivity. This work was done with the help of artificial pupils—a fact that was only realized 40 years later, after different attempts had been made to reduce them to the basis of natural pupils.

The " discrimination sensitivity " gives the limit values for the faculty of appreciation of light and shade. It can be defined in terms of the relation between the minimum brightness perceptible (Δe) and the actual brightness (e). In all of the following curves the reciprocal value $\frac{e}{\Delta e}$ is adopted, thus expressing the discrimination sensitivity. From the discrimination sensitivity curve shown in Fig. 1 (which is derived by tests of König and Brodhun†, and recalculated in consequence of the investigations of Schroeder‡) it can be seen that the discrimination sensitivity increases up to a brightness of approximately 200 lux on a white background‖, then remaining constant between 200 and 20,000 lux on white, to decrease again thereafter. The range between 200 and 20,000 lux on white therefore represents the conditions most favourable to the efficiency of the eye, so far as discrimination between minute differences in brightness is concerned. When higher values of brightness are attained the discriminating sensitivity decreases again in consequence of the of the steadily increasing glare. This

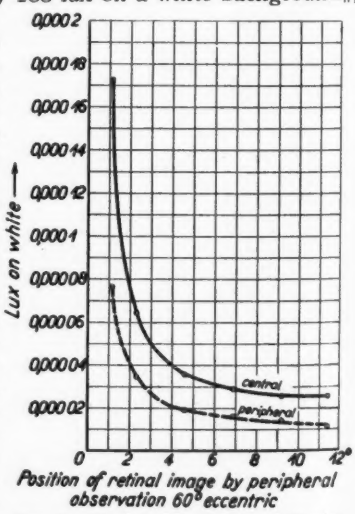


FIG. 2.—Absolute Threshold and Size of Stimulus Field. Emmetropic Eye.

* Teichmüller : Indust. Psychotechnik, 2, 193, 1925.

† König and Brodhun : Sitz.Bericht d.Anat.d.Wiss. Berlin, 8, 11, 917. König and Brodhun : Ges.Abh. z.Phys.Opt. Leipzig, 1903, S. 116.

‡ Schroeder : Zeitschrift f.Sinn.Phys., 57, 195, 1926.

‖ For the purpose of gaining a better picture of practical conditions, and also with a view to eliminating mathematics to a minimum, an expression has been adopted for the unit of brightness, i.e., that obtaining to a surface with a reflection coefficient of 100 per cent., which receives an illumination of 1 lux. This expression will be termed " lux on white," and is equal to $\pi.10^{-4}$ times the official unit of brightness (HK/cm^2).

discriminating sensitivity curve is naturally a special case for a certain brightness distribution in the field of vision, for the threshold brightness will invariably change considerably with the size of the field of vision, and with different brightness values falling within it. Fig. 2 shows the relation of the absolute lowest threshold to the size of the stimulus field with absolutely dark surroundings*. We see from the curve that the threshold decreases with an increase of the stimulus field; hence the discriminating sensitivity will increase with an increasing size of the stimulus field. The threshold is higher for central vision than for peripheral (i.e., an eccentricity of 60°). Next to the size of

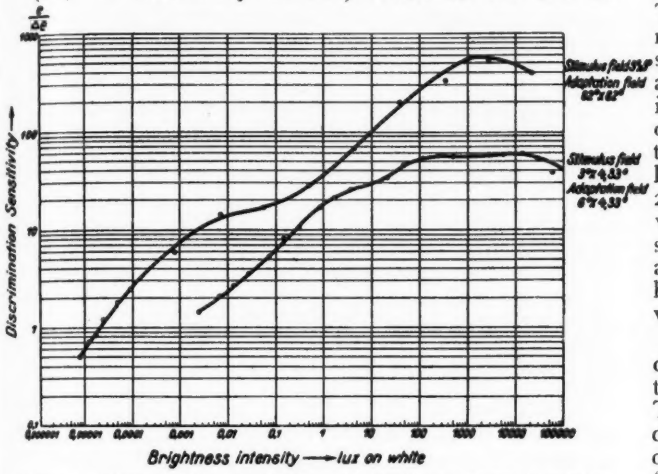


Fig. 3.—Discrimination Sensitivity with Small and Large Adaptation Field.

the retinal picture the distribution of brightness over the whole field of vision plays the most important part, as ultimately the condition of adaptation is dependent on it. This can be clearly seen if König's discrimination sensitivity curve is compared to that of Blanchard† (Fig. 3). In the lower curve of König a stimulus field of $3° \times 4.33°$ was used, and for the threshold stimulus a field of the same size, that is, a resulting stimulus field of together $6° \times 4.33°$, while the surroundings were held absolutely dark. Blanchard (the upper curve) on the other hand, used a stimulus field of almost the same size, viz., $5° \times 5°$, after first having adapted the eyes to a field of the size $82° \times 82°$, which would mean an absolutely even adaptation for almost the whole of the field of vision. Therefore, while König used a small, bright field in absolutely dark surroundings, Blanchard had a field of identical size with surroundings of the same brightness as the field of vision. A comparison of the two curves shows that in the latter case, where the inside field and its surroundings are equally bright, the discriminating sensitivity may be ten times as great as with a small bright field with dark surroundings. These facts have been proved by experiments carried out by Schjelderup‡. Fig. 4 shows the relation between the discrimination sensitivity of the inside field and surroundings. The unit of brightness amounts to about 20 to 25 lux on white. The brightness of the inside field amounted to 4.4 times this value, i.e., about 100 lux on white. The size of the inside field was 1°. The curve for the two persons tested showed that the discrimination sensitivity reached its highest value when the brightness of the inside field was equal to that of its surroundings. The discrimination sensitivity decreases if the surroundings become darker than the inside field, as is shown in the experiments of Blanchard and König, and also if the surroundings are brighter than the inside field; a fact of special importance for the lighting of surgical operating rooms. We can, therefore, say that the discriminating sensitivity increases with higher brightnesses up to the range between 200 and 20,000 lux on white, where it reaches its maximum value. It increases with the increasing area of the stimulus surface, consequently with the size of the object, and has its highest value when the whole field of vision has just about the same brightness as the object to be viewed.

These tests are only based on ability to determine differences in brightness without the necessity of having to distinguish exact forms or shapes of the contrasts. The ability to distinguish clearly the *form* of the differences of brightness, and consequently the shapes of the objects in the field of vision, will be termed "form or shape sensitivity"; for the moment it is immaterial whether these are the results of differences in reflecting qualities, of the degree of shadow, or whether they have been brought about in any other way.

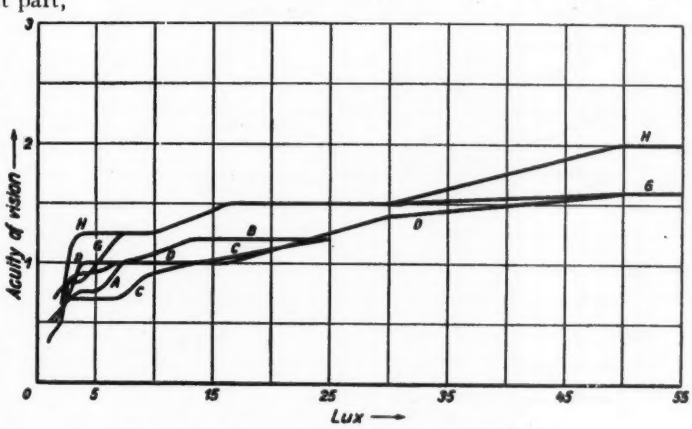


Fig. 5.—Relation of Acuity of Vision to Illumination.

We are at present only concerned with the retinal image itself, which is built up of differently sized, multi-shaped brightness intensities. Next to the factors influencing the discrimination sensitivity, e.g., the size of the object and the distribution of brightness in the field of vision, the "shape sensitivity" depends on the magnitude of the contrast, i.e., the shape sensitivity is greater with higher contrast values than with lower ones, and also becomes greater if the object increases in size. This circumstance cannot be attributed solely to the area of the light-sensitive parts of the retina, upon which the definition of the acuity of vision, as a special case of the shape sensitivity, is based. The acuity of vision is, as we know, defined as follows:—

"Acuity of vision '1' exists if two dots that are separated from one another by one arc-minute can just clearly be distinguished as separate dots." This definition already reveals the purely optical geometrical

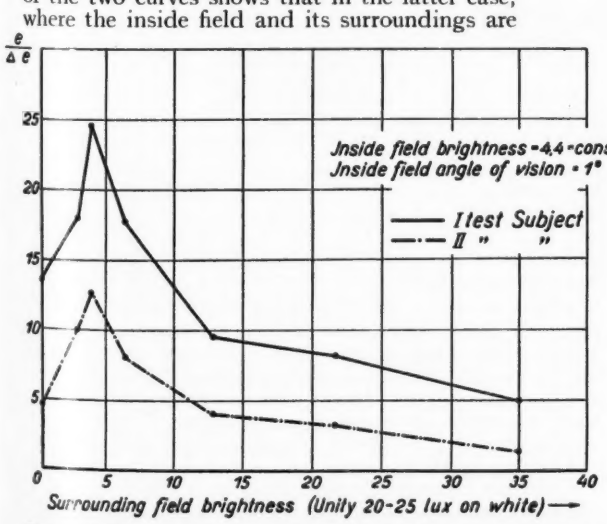

Inside field brightness = 4.4 = const.
Inside field angle of vision = 1°
I test Subject
II " "
Surrounding field brightness (Unity 20-25 lux on white) —

Fig. 4.—Influence of the Surrounding Field Brightness on the Discrimination Sensitivity, inside Field Brightness held constant.

* Borchard: Zeitschrift f. Sinn.Phys., 48, 176, 1914.
† Blanchard: *Phys. Review*, 11, 81, 1918.
‡ Schjelderup: Zeitschrift f.Sinn.Phys., 51, 188, 192.
§ Korff-Peterson: Münchener Mediz. Wochenschrift, 1919.

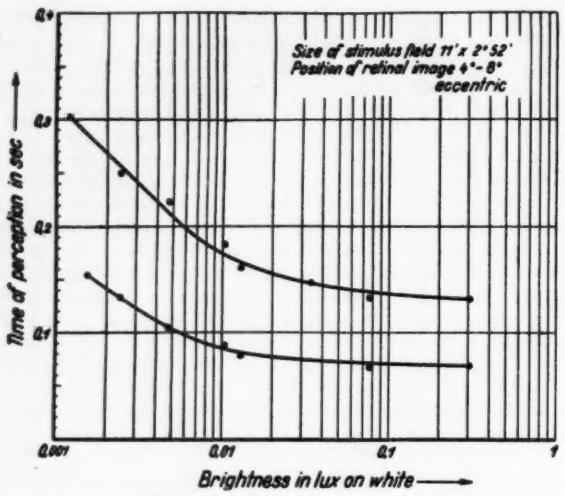

Size of stimulus field 11' x 2° 52'
Position of retinal image 4°- 8°
eccentric
Time of perception in sec
Brightness in lux on white

FIG. 6.—Brightness and Time of Perception necessary with Eccentric Observation and Dark Adaptation.

character of the conception of acuteness of vision. Fig. 5§, giving the curves of visual acuity as a function of the illumination with six test subjects (A–D, G and H), shows that not all of the test subjects reach the visual acuity " 1 " at the same level of illumination. The visual acuity varies with individuals, and also the shape of the curve relating this function to the intensity of illumination. In practical visual acuity tests a certain fairly exact contrast between black print on white paper (as a rule 1 : 20 to 1 : 30) is taken as a basis. In the same manner the forms of the test objects (either letters of the Snellen chart or the Landolt's rings, etc.) are as simple and clear as possible. But the different forms existing in actual practice are, as already mentioned, decidedly more complicated, and have very often much lower contrasts. Thus the contrast of soft lead-pencil writing on white drawing paper is only 1 : 3.3, and that of a hard lead pencil on white paper even as low as 1 : 1.7.

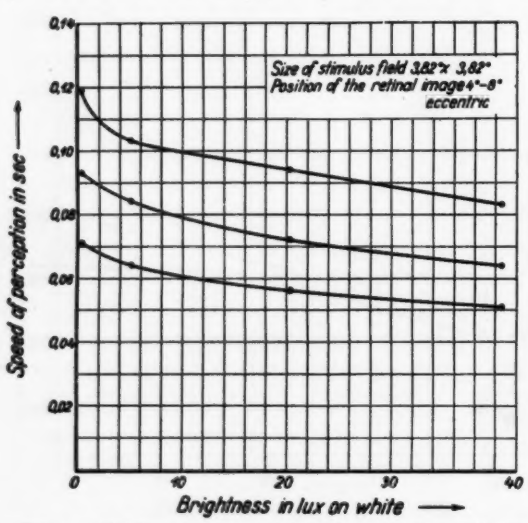

Size of stimulus field 3.82°x 3.82°
Position of the retinal image 4°-8°
eccentric
Speed of perception in sec
Brightness in lux on white

FIG. 7.—Brightness and Time of Perception necessary with Eccentric Observation and Moderately Bright Adaptation

The necessary range of brightnesses for the highest shape sensitivity, depending on the contrast and the sizes of the objects viewed, is often lower than that necessary for a maximum of discriminating sensitivity. But in recognizing smaller objects possessing only slight differences of brightness, much higher brightness intensities, and therefore higher illuminating intensities are often necessary, as shown by the research work of Ruffer*. These experiments involved the inspection of very fine tungsten wire, such as that used for the filaments of electric lamps, against a dark background. Intensities of illumination up to 10,000 lux (840 foot-candles) were attained before a limit in shape sensitivity was reached.

For the recognition of details in discrimination sensitivity and shape sensitivity tests a time limit was not imposed. But in actual practice, especially when viewing moving objects, quite a number of impressions must be observed by the eye in very short intervals of time, a fact that may greatly impede the procession of discrimination. As a matter of fact, it will be seen that the so-called time of perception, i.e., the time that must elapse between the retinal impression and its apperception in the brain, diminishes with increasing brightness, so that the speed of perception becomes greater with increasing brightness. The measurement of this " time of perception " is extremely different, as a certain time must, of course, also elapse before the perception of the retinal impression and its reactions on the test subject can be recorded either by optical or acoustical signals. A method worked out by Fröhlich† for measuring the time of perception gives the results shown in Figs. 6 and 7. Fig 6‡ shows the course of the " time of perception " curve in seconds as a function of the brightness, with a brightness range of 0.002 to 0.3 lux on white (0.0002 ./. 0.03 foot-candles on white), in paracentrical vision of the stimulating field having an area of 11′ × 2° 52′ with the eye absolutely adapted to darkness. This curve shows that the time of perception decreases with increasing brightness of the stimulating field and that the speed of perception therefore also becomes greater. Fig. 7§ gives the trend of the " time of perception " curve with a larger stimulating field of 3.8° × 3.8° with a paracentrical line of vision and a moderate adaptation of brightness that, unfortunately, was not precisely determinable. Here also we notice a decrease of the perception time for brightness intensities of the stimulating field up to 40 lux on white (4 foot-candles on white), and, for this reason, an increase of the speed of perception with an increase in field brightness.

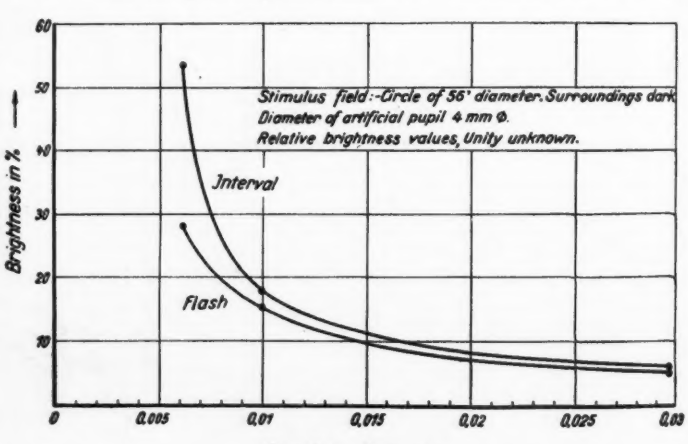


FIG. 8.—Sensitivity Thresholds of the Brightness for Light Stimuli of Short Duration.

The combination of discrimination sensitivity and speed of perception gives the perception threshold of brightness for stimuli of short duration. These threshold values therefore reveal the least time necessary to be just able to recognize a brightness of a given value and size; or, vice versa, establish the brightness essential for perceiving a stimulus of a given short duration. Gildemeister has developed a measuring method for these determinations. Figs. 8 and 9 give the resulting data from such an investigation by one of his co-workers‖. Fig. 8 shows the course of the necessary intensities of brightness for stimuli of short duration. A circle with the diameter of 56 minutes was used as a stimulating field; the field surroundings were kept dark, and the

* Ruffer : *Licht und Lampe*, 487, 1926.
† Fröhlich : Zeitschrift f.Sinn.Phys., 54, 58, 1922.
‡ Vogelsang : Zeitschrift f.Sinn.Phys., 58, 38, 1926.
§ Fröhlich : Zeitschrift f.Sinn.Phys., 59, 1, 1923.
‖ Rutenberg : Zeitschrift f.Sinn.Phys., 48, 268, 1914.

observations were made with an artificial pupil. The values of brightness are only relative, as the absolute values were not to be derived from the observation data available. These stimuli of short duration may be of a twofold nature; either the stimulating field suddenly appears on a dark background for a short time or the stimulating brightness remains unaltered and is merely interrupted for a short while. The lower curve, named "Blitz" (flash), gives the result of the first testing method; the upper curve, named "Pause" (interval), that of the second method. Fig. 9 gives the necessary duration of stimulus as a function of the brightness under otherwise similar conditions. Both curves show that the necessary duration of stimulus for the "Blitz" curve is lower than for the "Pause" curve, and that the duration of the stimulus decreases with increasing brightness, or that with increasing duration of the stimulus lower brightness intensities are perceptible.

(To be continued.)

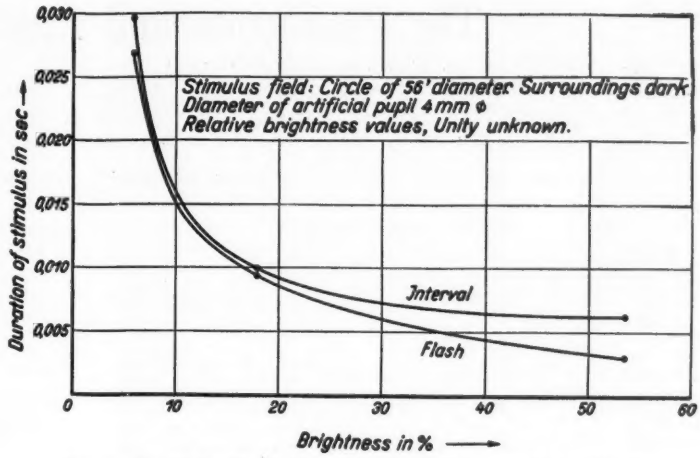


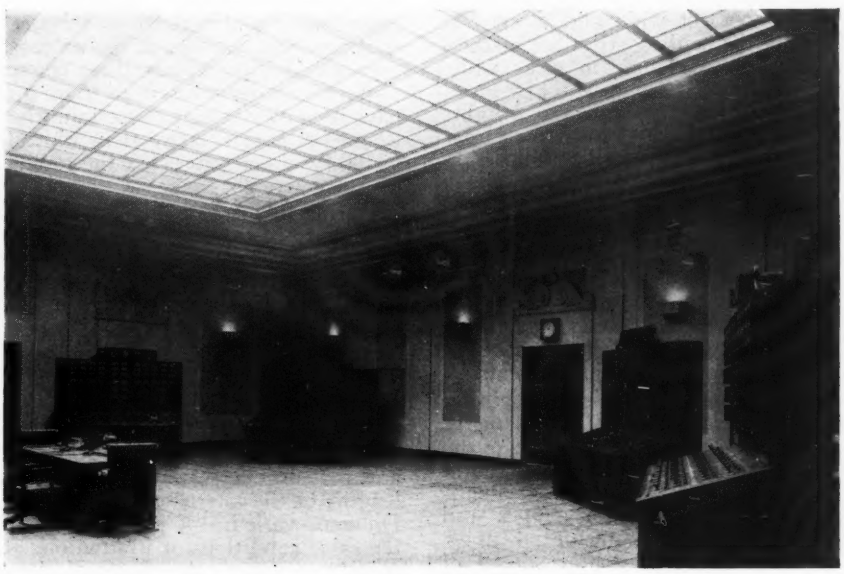
FIG. 9.—Sensitivity Threshold of Stimulus Duration for Light Stimuli of Short Duration.

Overhead Lighting in the Control Room of a Large Receiving Station

IN a recent issue of *The Electrical World* an interesting account was contributed by Mr. C. P. Garman describing the developments of the system of the Bureau of Light and Power in Los Angeles. Los Angeles has doubled its population within five years, and the necessity of extending the electrical system has to be constantly borne in mind. This has resulted in a transmission and distributing system which embodies many novel features, a number of receiving stations supplied from transmission lines controlled by synchronous condensers being utilized.

By the courtesy of *The Electrical World*, we are reproducing a view of the operating room in the control house, which is interesting in view of the special method of lighting employed. The chief problem is one that is not infrequently met with in picture galleries—the avoidance of troublesome reflections in glass surfaces. Distributed round the room are many instruments with glass faces. If lighting was effected by units distributed hung from the ceiling inconvenient reflections of lamps in these dials would occur. Accordingly a method of lighting from above has been adopted, all light entering through a diffusing skylight, though this method is supplemented by a certain number of shielded lights round the room.

Apart from its avowed object of avoiding reflections, this method has the advantage of leaving the room quite free, so that anyone standing in the centre has an uninterrupted view of all panels and instruments within it. This shows how a somewhat special lighting problem has been dealt with, and the method is worth bearing in mind when designing other interiors of this nature, such as those devoted to telephone switchboards, etc.



Showing the Lighting of the Operating Room in the Control House of a Los Angeles Receiving Station. All light enters from the skylight above, so as to reduce troublesome reflections on dials of instruments to a minimum.

Data on Street Lighting

A useful illustrated booklet on street lighting, forming one of the series of lighting data bulletins, has been issued by the Edison Lamp Works of the General Electric Company (U.S.A.). There is an introductory article setting out the benefits of good street lighting, and illustrations of a number of different types of units are shown. These are mainly of the decorative type, having diffusing outer globes with inner prismatic directive devices.

The Production and Application of Light

(In what follows we give a summary of the Annual Report of the Committee on Production and Application of Light, which was presented at the Summer Convention of the American Institute of Electrical Engineers at Denver, Colorado, last year. Mr. Preston S. Millar, the Chairman of this Committee, has kindly sent us a copy of this report, which contains an informative survey of recent developments.—ED.)

(*Continued from p.* 254, *September.*)

Lighting for Aviation.

During 1927 much work has been done in the lighting of airways in order to promote the safety of night flying. At the present time 5,800 miles of air route are provided with flying facilities which include beacon lights 10 miles apart, or closer where required, lighted intermediate landing fields 30 miles apart, radio communication service for weather information and forecast, reports of arrivals and departures, and direction and control of aircraft in flight. The beacon lights are erected on 50 or 75 feet steel towers, at the bases of which are chrome yellow arrows 56 feet long to indicate the line of flight. The number of the beacon is painted in black on the arrow for daytime identification. The beacon light consists of three units, a revolving searchlight synchronized with two flashing red course lights. The revolving beacon has a 24-inch parabolic mirror and a 1,000-watt, 110-volt, T20 incandescent lamp designed to yield an average life of 500 hours. The beacon develops a beam intensity of between two and three million candlepower. Its axis is elevated 2° above the horizontal and it is rotated about a vertical shaft by a motor and worm gearing at a rate of six revolutions per minute. Auxiliary contactors on the vertical shaft interrupt the current to the course lights according to a code by which the pilot identifies the beacon.

Intermediate landing fields are marked with a revolving beacon, a boundary lighting system, obstruction lights, and an internally lighted wind cone. The fields usually have two landing strips at right angles to each other, each about 500 feet wide and 2,000 feet long. The boundaries of the landing strips are marked by 15-watt or larger multiple lamps in clear white refractor globes, spaced about 300 feet apart, or by series lamps of equivalent candle-power. Green range lights mark the favourable approaches and 25-watt or larger multiple lamps in red globes are mounted on all neighbouring obstructions.

To meet the requirements for terminal fields 425 airports have been established or are under construction by municipalities in the United States. The Department of Commerce has established an airport section to co-operate with city officials for proper selection and development of airports. Extensive tests were made during the past year in the landing of aircraft at night under varying conditions and floodlighting systems.

The outstanding developments in airport lighting during the year were a new system of grouping of incandescent floodlight units on one or more sides of the landing field, an intermediate size dioptric floodlight unit using the 5-kilowatt incandescent lamp, illuminated field markers and wind-direction gauges and a 55-ampere high intensity arc floodlight unit, with 2° vertical and various degrees of horizontal spread of beam. Neon tube beacons and boundary lights have been advanced in development during the year and it is understood that in Great Britain and Germany they are employed very generally in lighting for aviation. A practical method has been demonstrated for automatically controlling landing-field floodlights through switches actuated by the noise of the airplane or by a whistle of distinctive tone mounted on the plane.

Lighting for Night Recreation.

Artificial lighting is being used more and more to extend the uses of recreational areas into the dark hours. Lighting installations for night tennis, football, races, bowling on the green, hockey, horseshoe pitching (quoits), and indoor baseball are numerous and assure the practicability of night sports. Extensive investigations at Lynn, Mass., indicate that in no very distant future the great national game of baseball may be played at night under artificial illumination.

During the past year special progress has been made in the application of artificial light to swimming pools. In addition to levels of illumination of the order of 5 to 10 foot-candles over the entire pool area, to ensure safety and comfort it has been found desirable and feasible to provide, in the deeper parts, under-water illumination from units below the surface. Equipment which can be installed quite economically has recently been made available for this service.

Under-water Lighting and Diving Lamps.

The standard diving lamp adopted by the U.S. Navy and approved by marine salvage companies now consists of a 1,000-watt G40 extra heavy glass bulb lamp, 115-volt range, with concentrated filament construction. These lamp bulbs are tested to withstand a pressure of 150 lb. per square inch, which suffices for submersion to a depth of 300 feet. The bulb is mounted in a housing some 18 inches long with a non-tarnishing metal reflector 11 inches in diameter. In operation the lamp bulb is in direct contact with the water, being protected only by a heavy wire screen across the mouth of the reflector. The problem of overcoming water leakage has been solved by the use of a special insulating sleeve surrounding the base of these lamp bulbs. To prevent the crushing of the lamp base and the seal, which are the weakest points of the structure, special reinforcement has been introduced. These lamps have proved very useful in recent salvage operations on the submarine S4. Although the water near the bottom was very muddy, the divers there engaged reported good visibility at distances from 3 to 6 feet. Experiments have been conducted to ascertain whether coloured light would be more effective than white light in promoting visibility under water, but the results have been chiefly of a negative character.

During the past summer under-water lamps were used in a study of tropical marine life off the coast of Haiti. Both clear and coloured lamps were used and the attracting power of light for certain fish seemed well demonstrated. It is reported that electric incandescent lamps are in use as bait by Japanese fishermen.

Lighting for Agriculture.

Recent investigations into the relation of light to plant growth and maturity have been concerned with the relative effects of radiations of different wavelengths, and the effects of variations in the relative and absolute lengths of the alternate periods of light and darkness. Different varieties of plants differ in their reaction to the same conditions of irradiation. Some difference of opinion regarding the effects of ultra-violet light seems to exist. It has been shown by several experimenters in this field that ultra-violet radiation of wavelengths shorter than 248 millimicrons is injurious to growing plants.

Long periods of illumination produce in some plants increased vegetative growth, while in others they bring about early maturity. Recent experiments have led to the conclusion that with plants in which flowering is favoured by short days, as well as with those in which the opposite is true, the general effect of relatively short alternations of light and darkness on reproductive activities is much the same as that produced by long days of continuous illumination. However, it was also observed that the short light-darkness alternations may bring about more or less serious nutritional disturbances.

The attraction of light for insects has been used for many years in luring them to their destruction. A

recent application of this principle was made in Alabama where fruit worms had caused severe losses in the tomato crop. With 100- and 200-watt lamps and flat reflectors suspended 5 feet from the ground and over pans of water covered with kerosene, the protection was reported to be so complete that only 35 worm-infested tomatoes were found in two acres, whereas neighbouring unprotected fields suffered losses from 30 to 50 per cent. That colour is a factor in the attraction has been shown in some results obtained at the State Experiment Station at Geneva, N.Y. It was found that "tent caterpillars," a most ravenous insect pest, would leave young apple twigs and gather in places where there was plenty of light, though little fodder. With differently coloured lights, the apparently hungry caterpillars usually went directly to those of a pale yellow. Some preferred a deeper yellow, but red light appealed to only a few. It is believed that there is room for considerable further experimentation in this field, as with lights of different colours and different intensities.

The use of artificial light in poultry houses during the winter months has become a common practice on many poultry farms. The usual method is to turn on the lights for a short period morning and night in order to extend the period of daylight, thus stimulating the activity of the hens and increasing their food consumption and egg production. Electricity is also being used in experimental work to furnish ultra-violet rays to young chicks and also to laying hens which are kept confined where they do not get direct sunlight, the effect of the ultra-violet radiation being to promote bone formation and to prevent the occurrence of leg weakness, a condition resembling the disease in human beings known as rickets. The more common practice, however, is to accomplish this result by administering with the chickens' feed a ration of cod liver oil, which has the same specific effect as ultra-violet radiation.

Sources and Applications of Ultra-violet Radiation.

The general interest in the health-promoting use of ultra-violet radiation has led to the introduction of windows transmitting all of the sun's short-wave radiation and for artificial sources emitting little or no radiation of higher frequency than that present in direct sunlight. The degree of transparency to ultra-violet radiation of such special window-glasses varies greatly, and the transparency of certain materials tends to deteriorate with exposure.

Two new industrial applications have been well established during the past year. The application of ultra-violet radiation from artificial sources to the hardening of the varnished surface of patent leather has been successful in effecting a higher quality of product with a much shorter treatment than was possible by the former method of exposure to sunlight. The exposure of dried milk powder to ultra-violet radiation has resulted in the production of an infant food having marked antirachitic properties. A similar use of ultra-violet radiation in connection with the preparation of other food materials is under investigation.

Photometry.

The advent of the four-element vacuum tube has made it possible greatly to improve the sensitivity, speed, and precision of photoelectric spectrophotometry. The photoelectric cell containing a monomolecular layer of caesium represents a distinct advance over the earlier types in stability of colour sensitivity and in approach to eye sensitivity. A recent development of floodlights and other projectors has been the use of a concave spherical mirror in place of a diffusing hemisphere for integrating the light flux over a unit of solid angle.

Miscellaneous Applications of Light.

An interesting and novel application of light is in a device recently developed for measuring the change in length of a small specimen of magnetic material upon magnetization. This change of length is of the order of a billionth of an inch. In this apparatus the image of an illuminated portion of a ruled grating is reflected back upon another portion of the grating by a pivoted concave mirror which is arranged to tilt slightly when the length of the specimen changes. Behind the second portion of the grating is a photoelectric cell. As the mirror tilts the image moves across the grating, causing a variation in the amount of light transmitted to the photoelectric cell. The response of the cell, as indicated by a sensitive galvanometer, is a measure of the tilt of the mirror and of the change of length of the specimen.

A recent application of ultra-violet radiation and the photoelectric cell is in a device for the automatic concentration of ores. The crushed raw ore on a belt passes under a source of ultra-violet radiation which causes the pieces of valuable material to fluoresce strongly, while the pieces of worthless rock remain unaffected. A photoelectric cell screened from the ultra-violet radiation picks up the visible light of the fluorescent material and actuates a device which separates this material from the rock.

Radiation from the Aurora Borealis

We have received from Dr. Elmer A. Smith, of Secaucus, N.J., an interesting account of some experiments conducted by him during recent manifestations of the aurora borealis. Data obtained in these researches suggest that the high-frequency rays and electromagnetic waves discharged from the aurora are the direct cause of disturbance to high-power transmission systems. The rays are of exceedingly high penetrating power, and cover a wide range of frequencies. The experiments were conducted by the aid of a concrete pipe shaft with lead lining, installed in the channel of the Hackensack River, electroscopes and other sensitive instruments being mounted at the base of the shaft. The atmosphere exercises a marked absorption effect, being equivalent to 28 feet of water. As the high-frequency rays were found to be capable of penetrating 103 feet in addition, the total penetrating power is estimated to be equivalent to 131 feet of salt water. The rays can penetrate nearly 13 feet of lead, whereas the most penetrating X-rays in use to-day cannot pass through more than half an inch. These "aurora" rays are apparently far more penetrating than any other rays known, and they are believed to represent a new range of radiation in the spectrum, as far above the X-rays as are the discovered rays above the frequencies of light waves.

These experiments are of special interest in view of the high penetrating "cosmic rays" recently investigated by Millikan and Kohlhorster. It has been inferred that the rays were of extra planetary origin, but Dr. Smith's experiments seem to suggest that they may be derived from the disturbances caused by the aurora borealis.

Industrial Research in Australia

The Council for Scientific and Industrial Research in Australia appears to be making good progress. In a recent issue of the *Journal*, Dr. A. C. D. Rivett contributes an analysis of its aims and policy. It is satisfactory to note that the Council is receiving cordial assistance from many sources, including the State scientific departments and the universities. Hitherto it has followed five main lines of investigation—animal problems, plant problems, food preservation, forest products, and fuel research—all questions of special local interest. Naturally, for the moment, agricultural problems command most consideration; but no doubt in course of time the Council will be able to grapple with industrial problems, and we hope that eventually we shall be able to record valuable work from Australia in connection with illumination, on lines similar to those pursued by the Department for Scientific and Industrial Research in this country.

The report also alludes to the work of the Department of Scientific and Industrial Research in New Zealand, which is also of quite recent origin, having been formed in 1926, but has already been responsible for the initiation of useful researches.

Developments in Factory Lighting

Some Notes on the Report of H.M. Chief Inspector of Factories for the Year 1927*

THE annual report of H.M. Chief Inspector of Factories for the past year, as usual, reveals some interesting tendencies in industrial development. On the whole, most industries seem to have been steadily recovering from the disastrous results of the coal dispute of 1926, though marked depression in certain trades, and remarkable activity in others, is to be noted. Amongst the latter the artificial silk industry is singled out for special mention. New works are being opened in various parts of the country, and the industry is becoming well distributed geographically. The tendency to remove businesses from the more densely populated areas of London to the outlying suburbs and Home Counties continues. It is also noteworthy that important industries seem to be now developing in the southern areas, especially in he south-east of England.

There is again evidence of the disappearance of the small country establishments; the saddler, blacksmith, village tailor, dressmaker and milliner are all steadily going out of business. The number of registered factories has risen from 145,411 to 147,501, and the number of registered workshops has slightly diminished from 121,861 to 117,066. It is stated that during the last 20 years factories have increased almost by 40 per cent., whilst workshops have fallen by 26 per cent. This seems to show that the small employer tends to drop out and that mass production in large and highly organized establishments is steadily replacing the village and rural workshop.

The general report dwells particularly on safety and the growth of safety methods in factories. Allusion is made to the recent opening of the Home Office Industrial Museum. A descriptive account of the museum, the only one of its kind in this country, is given in a special chapter, and attention is drawn to the special section devoted to lighting, which has already been described in *The Illuminating Engineer*.†

The section of the report of chief interest to our readers is naturally that dealing with *lighting*. The work of bringing to the notice of employers the recommendations of the Departmental Committee on Lighting in Factories and Workshops has been continued. Two members of the staff were again detailed to make measurements of illumination during the winter months; Miss Coombes in cotton and woollen mills and Mr. Shopland in engineering, motor-cars, cycles, boots and shoes, and other special industries. This work serves a double purpose, as it arouses interest in the subject and proves the feasibility of setting up a legal standard of lighting for any particular industry or any particular process.

The depression in the textile industries resulted in less artificial light being used, but furnished more opportunities of discussing illumination with persons interested.. Not only do more people now take an interest but there are signs of a much wider grasp of the principles of good lighting. Recent propaganda seems to be filtering through to the man at the works responsible for lighting conditions, and some trade pamphlets contain instructive material. At several works Miss Coombes was shown copies of such pamphlets, and found experiments on lighting in progress. In the large worsted mills at Bradford a high standard of lighting is necessary for the fine work undertaken. Engineers in charge have frequently expressed their appreciation of the value of photometers in studying the arrangement of light sources. In many departments of textile works the chief problem is that of obtaining equality of illumination on the whole length of the very large machines. Burling and mending or darning of cloth requires specially good light; of eight readings taken for such processes all were above 5 foot-candles, and four gave over 20 foot-candles.

Miss Coombes took 173 readings in cotton mills on processes for which a standard of 3 foot-candles would probably be recommended; 109 readings were below this standard. In woollen mills, where a similar value would apply, 52 readings were taken, and of these 20 were below 3 foot-candles. In Scotland special experiments designed to improve the lighting are reported. In one instance it was found that women engaged on burling and darning suffered from headaches; these have been entirely obviated by a better system of lighting, special attention being devoted to shading and to light being received at the right angle. In another case blue glass bulbs have been substituted for ordinary clear ones with good results.

Mr. Shopland, in the industries surveyed by him, took 287 readings. The highest standard was in the boot and shoe trade, only four readings being under 3 foot-candles, and 54 readings being up to 5 foot-candles or over, whilst 18 exceeded 20 foot-candles. In the engineering trade the standard was low, 25 out of 125 readings being below 3 foot-candles. As a whole, the standard falls at least 30 per cent below that recommended by the Departmental Committee—chiefly owing to incorrect distribution of light and imperfect shading. Glare arising from the use of shallow reflectors is common; where such lights are in close proximity to workers engaged on fine processes headaches are common. In many cases lamps and reflectors were also found to be in a dirty condition.

Attention to lighting, however, has not been confined to these two enquiries. Reports from all divisions show that the subject is receiving more attention and that a gradual improvement is taking place. In some cases more modern conditions, such as the driving of individual machines from special motors, and the elimination of overhead belting and shafting, has facilitated the provision of better lighting. Painting of walls white, especially in proximity to machines, has also had a good effect. In one factory useful aid was obtained from small mirrors arranged close to each sewing machine, in order to reflect the daylight more directly on the work.

Instances of inadequate lighting of staircases, passages, yards and sanitary conveniences are recorded; also cases where absence of light made the conditions dangerous owing to the presence of machinery. In one factory a large motor with unguarded belt and pulley was in use in a small room in which there was not any means of lighting, natural or artificial. The motor switch was inside the room, and the man kept his outdoor clothing there. In another case no lighting was provided in an engine room, which, even during the daytime, was so dark that it was impossible to distinguish different parts of the engine. Yet another striking case was that where a boy was operating a power press in a dark corner of a shop. No guard was provided, and there was dazzling glare in his eyes caused by a powerful lamp so placed that a shadow was cast over the work.

* Annual Report of the Chief Inspector of Factories and Workshops for the year 1927. (H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. Cmd. 3144; 2s. 6d. net.)

† March, 1928, p. 77.

Association of Special Libraries and Information Bureaux

The fifth annual conference of the above Association was held at New College, Oxford, during September 14th–17th. The papers covered a wide range and dealt with many topics of interest to the technical journalist. Lieut.-Col. J. M. Mitchell dealt with the Aslib Directory, and there were papers dealing with Patent Law Reform, Indexes to Technical Periodicals, and the Unification of Library Resources in London. Another interesting item was the contribution by Dr. Rosenhain, of the National Physical Laboratory, on Scientific Abstracts.

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)

The Need for Better Factory Lighting

THE opening of this season's Factory and Workshop Lighting Campaign, now being conducted by the British Electrical Development Association, illustrates the growing recognition of the vast field for improvement in industrial lighting. The campaign includes the issue of letters and leaflets to over 100,000 factories in this country, and the circulation of information to those concerned with the lighting of textile, printing, engineering and other specialized trades. This

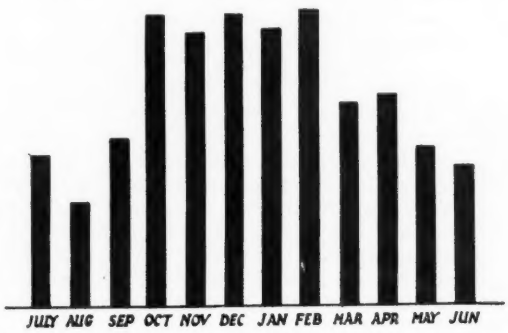


FIG. 1.—Good Lighting Increases Safety. Accidents increase when daylight fails.

effort will be supplemented by articles and advertisements in the lay and technical papers, and the organization of exhibitions and lecture demonstrations. Consumers will be recommended to install trial installations, and replies to inquiries will be followed up

FIG 2.—Good Lighting means Absence of Glare and Dense Shadows.

systematically. The literature prepared for the campaign includes some useful educational leaflets. Of special interest is the little booklet entitled " Factory Lighting Facts," which contains eleven effective illustrations emphasizing fundamental principles in industrial lighting and benefits to be secured. We reproduce on this page four typical illustrations (Figs. 1–4).

These points are set out in a broad and simple form, readily understood by consumers. Experts agree that more information on the exact relation of illumination to industry, and its influence on production in various

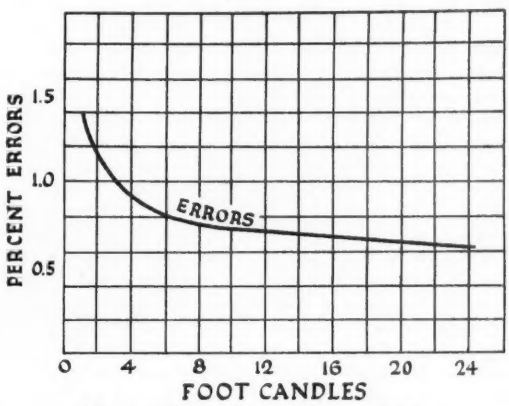


FIG. 3.—Good Lighting Reduces Spoilage.

trades, is needed. But there is little doubt that the great majority of factories in this country still receive too little light, and that in many cases the available light is not used to the best advantage.

Illumination and Production Power.—The intimate

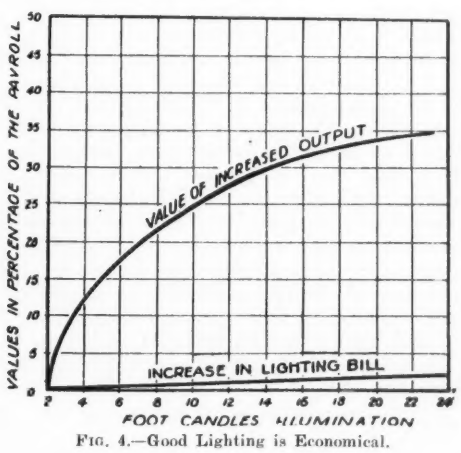


FIG. 4.—Good Lighting is Economical.

relation between light and industry may perhaps be illustrated by taking an extreme case. It is no longer true, thanks to the progress of illuminating engineering, that " the night cometh when no man can work." But it is certainly true that in complete darkness practically all forms of work must come to a standstill. Going a

little further, imagine what happens when only a feeble light is available. Many varieties of fine work still cannot be done at all. Very simple operations may still be performed, but only slowly and painfully. As the light is further increased workers become conscious of greater ease and confidence, whilst in full illumination they are free to put forth their best efforts.

The relation between illumination and production has been much discussed. This is really by no means a simple problem. Not only is a high illumination often necessary to enable small objects or minute details to be quickly and clearly perceived, but without adequate illumination the *sense of confidence*, which is essential to quick action, is missing. This factor is of the more importance because of the ever-increasing tendency to mass production in highly organized factories employing intricate machinery. With the coming of the industrial era conditions of work became radically changed. Men no longer worked as individual units—as weavers worked originally in their own homes, each with their own apparatus, and by the light of a single candle or oil lamp. Instead there came about organized effort, each worker forming one of a community whose efforts dovetailed into each other. The mere fact of complex machinery being introduced rendered better lighting of the room as a whole essential to safety. Similarly illumination had to be provided for the workers as a mass, not merely for individual workers.

Inadequate Illumination Causes Accidents.—In the modern factory the results of inadequate and unsuitable lighting are more seriou sthan in the past. For one thing, the order of accuracy required in modern machinery is far higher than in olden days. An article is rarely completed by a single workman. Parts from different sections of the workshop must be assembled and must fit together with perfection. An apparently small error in the manufacture of one part may throw out of gear a whole process. Yet this work must be completed with a speed undreamed of by the craftsmen of the past. Apart from the economic loss involved in mistakes and spoiled work, and the slowing down of effort caused by inability to clearly, it is evident that with poor lighting the hazards of industrial work are increased. It requires little imagination to understand how accidents become more frequent when the outlines of running machinery cannot be quickly seen, or when the eyes of a worker using a cutting tool are dazzled by improperly arranged lamps. A single bad accident may influence factory routine for a long time afterwards, slowing down effort and checking confidence. And it is not only the worker but his tools that suffer. Machines in inadequately lighted workshops are rarely kept in perfect order. Defects are less visible and are neglected. Plant that cannot be clearly seen is apt to become dirty; and dirt is one of the worst diseases which machinery can suffer from.

On broad principles, therefore, the value of good lighting in the factory can be amply justified, especially when it is considered that the cost of lighting usually forms but a small fraction—often less than 1 per cent.—of the cost of production. It is obvious folly to pay high wages to skilled workmen and install expensive machinery, and then to grudge the cost of the light necessary to enable them to do their duty.

Fundamental Principles in Factory Lighting.—The fundamental principles underlying all industrial lighting were summarized very simply and clearly in the first interim report of the Home Office Departmental Committee on Lighting in Factories and Workshops, issued in 1915, and may be briefly restated as follows:—

(1) There should be sufficient illumination over the working area.
(2) The illumination over this working area should be reasonably constant.
(3) Lamps should be so placed and shaded that the light from them does not fall directly on the eyes of a worker when engaged upon his work, nor when looking horizontally across the workroom.
(4) Lights should be so placed as to avoid the casting of inconvenient extraneous shadows on the work.

To these four principles, involving the provision of sufficient and reasonable constant illumination, absence of glare and elimination of troublesome shadows, may be added a fifth—which was emphasized in a subsequent report—absence of flicker. Fortunately flickering light is not usual when lamps are run from the ordinary gas or electric supply, though it may be met with in imperfectly designed private plants.

Sufficiency of Illumination.—The first report of the above Committee recommended a minimum illumination of 0.25 foot-candle in all parts of a workshop in the interests of safety and general convenience, and *irrespective of the working illumination.* The illumination necessary for carrying on work naturally varies according to the " fineness " of the work and the complexity of the process. In the third interim report the Committee presented a schedule of operations classed respectively as " fine " (requiring not less than 3 foot-candles) and " very fine " (requiring not less than 5 foot-candles). These may be regarded as minimum values, but even so there are very many factories to-day where they are not attained. On the other hand, there are already a number of factories where the management prefer, in the interests of efficient production, to adopt very much higher values—10 or 20 foot-candles, or even more. Only in the case of a few processes has the relation between intensity of illumination and production been scientifically studied as yet. The results of the inquiry of the Illumination Research Committee into the lighting of printing works suggested that full efficiency was only attained with an illumination of the order of 20–25 foot-candles, and there are doubtless many other forms of exacting work to which this conclusion would apply. It has been shown that in many cases the extra cost of these high illuminations is repaid by increased output and greater accuracy of work; but the exact economic limit will vary for each process, which should be studied on its merits.

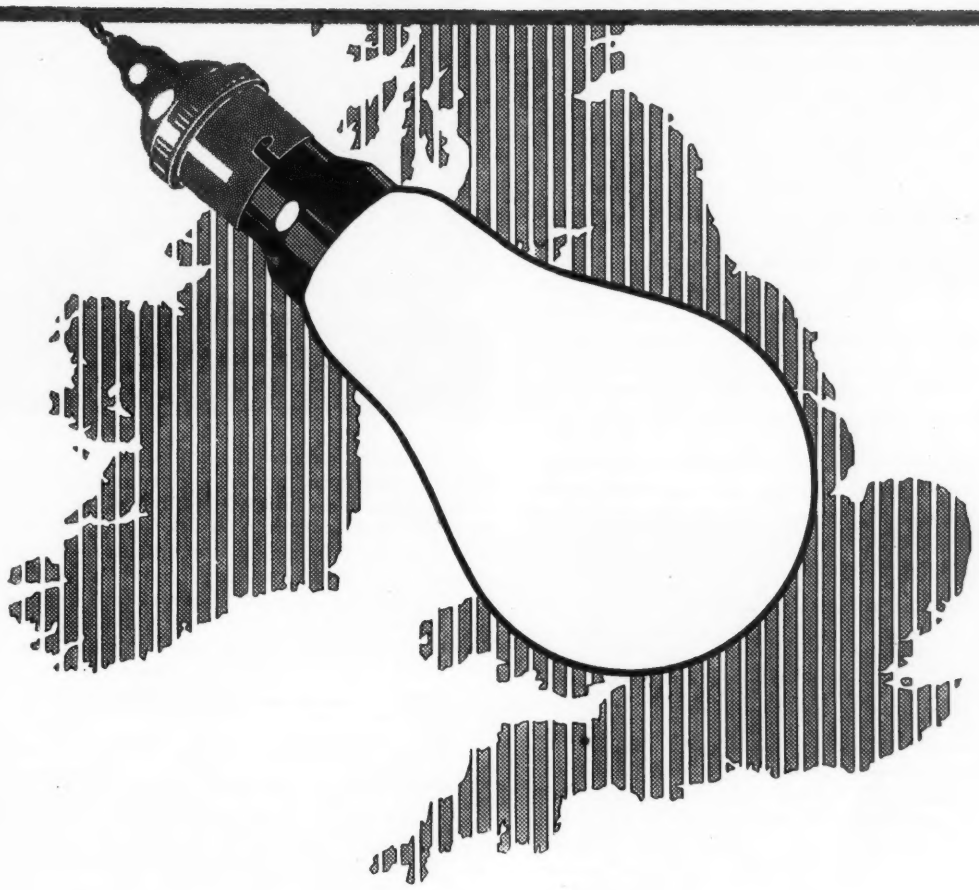
In considering intensities of illumination a distinction should be drawn between *minima* necessary for the health of the worker and in order to avoid industrial fatigue and values which may be desirable from the standpoint of efficient production. The former may well be studied and recommended by Government authorities; but the decision to adopt the latter must rest with managers of factories.

Elimination of Glare.—The provision of sufficient light is only half the battle. Absence of glare, troublesome shadows and flicker are equally important. Recommendations in regard to glare were included in the second report issued in 1921.

In the case of local lights the mantle or filament should be *completely screened* from the eyes of the worker. Sources equipped with diffusing glassware such that the filament or mantle is rendered indistinguishable may also, in many cases, be used at a relatively low level. If sources are not so shaded (e.g., if used in open reflectors) then we must ensure that the light from them does not strike the eye at angles less than 30°. This may be done either by mounting the lighting units high up, so as to be well up out of the range of vision, or by adopting scientifically designed reflectors with an angle of " cut-off " of, say, 20° (or preferably not less than 30° if mounted at a low level) such as are supplied by leading manufacturers. With the wide range of well-designed lighting units now available there is no reason why bare mantles or filaments should ever fall within the direct range of vision. The use of relatively deep reflectors and the introduction of the internally frosted, white-sprayed and opal bulbs has helped materially to eliminate the drawback of glare; in the case of gas lighting similar protection is afforded by the use of vitreosil and similar diffusing media. In a well-lighted, large modern workshop one can frequently look across the room without a single unscreened mantle or filament being visible.

Avoidance of Troublesome Shadows.—Troublesome shadows are eliminated mainly by two devices, careful attention to the positions of sources so that the person of the worker does not fall between the source and his

IN EVERY CORNER OF THE BRITISH ISLES



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work, and the use of diffusing media. The use of diffusing glassware aids greatly in producing soft shadows, and likewise the painting of walls and ceilings (and occasionally the non-working parts of machinery) in light colours, so as to furnish extensive luminous areas. Whilst these extraneous shadows should always be eliminated, it is not desirable that the light should approach a " shadowless " condition. Shadows cast by small projections in the material or irregularities in its surface often furnish a valuable guide to the worker; this is one reason why, for certain fine processes, adjustable local lights are often preferred.

Requirements of Special Processes.—If to the above requirements we add the necessity of keeping lamps and fittings in clean condition, and arranging for inspection at regular intervals, we have outlined fairly completely the main principles of good industrial lighting. But the lighting of factories can never be a rule-of-thumb process, and ideal conditions will be obtained only by an expert who is both conversant with the latest developments in illuminating engineering and familiar with the industrial process concerned. Such questions as the choice of general or local illumination (or a combination thereof), the method by which the light should be applied and directed to certain forms of materials or machinery, the influence of the texture and reflecting power of the material, and, in some industries, the desirability of adopting some form of artificial daylight, require consideration. Whilst, therefore, the fundamental principles of good industrial lighting are now well established, much remains to be learned regarding the exact requirements of different processes and industries, and investigations in this direction are now proceeding.

Some Typical Modern Industrial Lighting Installations

In the following pages we are reproducing a few pictures of typical modern lighting installations, all of which (when portraying artificial lighting) are based on photographs taken solely by the actual light of the fittings used. This is one respect in which great progress has been made. At one time such photographs were very difficult to obtain. To-day they are furnished by all the leading firms in the lighting industry.

A feature of many of these installations is the use of overhead lighting, providing quite high illuminations on the working plane. Reflectors, too, are of approved modern types with a satisfactory " angle of cut-off," so that one can look across the room without being conscious of glare. The illustrations show the variety of lighting installations which can be dealt with on these broad lines. Yet it should not be assumed, because the methods appear simple, that there is little thought behind them. On the contrary, each installation requires individual treatment, and considerable care must be given to the choice and spacing of lighting units so as to get the best effect.

Moreover, whilst most of these installations utilize general overhead lighting, cases constantly occur in which an exceptionally high illumination, obtained from local lighting units, is necessary. Nowadays such units are frequently used to supplement general lighting (it is now regarded as bad practice to rely on local lighting *alone*). These local lighting units also require to be designed on scientific lines. Apart from the primary requirement of completely screening the lamp from the eyes of the worker and concentrating a high illumination on the work, these units must be robustly designed, as they are frequently somewhat roughly handled, and in addition they should be highly flexible, so that the worker can adjust the position of the light to suit his needs exactly.

The Lighting of a Cotton Spinning Mill

This effective illustration, for which we are indebted to Messrs. Benjamin Electric Ltd., shows the lighting of a cotton mill in Spain. The photograph, taken by the actual light of the units provided, gives an idea of the good distribution of light. The illumination, furnished by 150-watt lamps in R.L.M. reflectors, was 7.5 lux (approximately 7 foot-candles). The units are mounted

well up out of the direct range of vision, allowing a free view of the entire room. The necessity for a good illumination in such intricate processes as these, involving the examination of much fine material in rapid motion, need scarcely be emphasized.

Incidentally the picture is interesting in illustrating the development of modern methods of lighting in Spain —a country from which one does not hear a great deal about illuminating engineering, though we understand that considerable progress is being made.

The Lighting of a Metal Foundry

The accompanying illustration shows the lighting of a section of a brass-rolling mill, carried out to the specification of Messrs. Metro-Vick Supplies Ltd. Overhead illumination is furnished by 500-watt lamps in skirted dispersive reflectors, which are mounted 18 feet high and 19 feet apart. The illumination provided is 7 foot-candles, a value which is doubtless desirable in view of the dark surfaces of much of the material worked with.

In the furnace section a somewhat lower value of illumination (4 foot-candles) was considered sufficient.

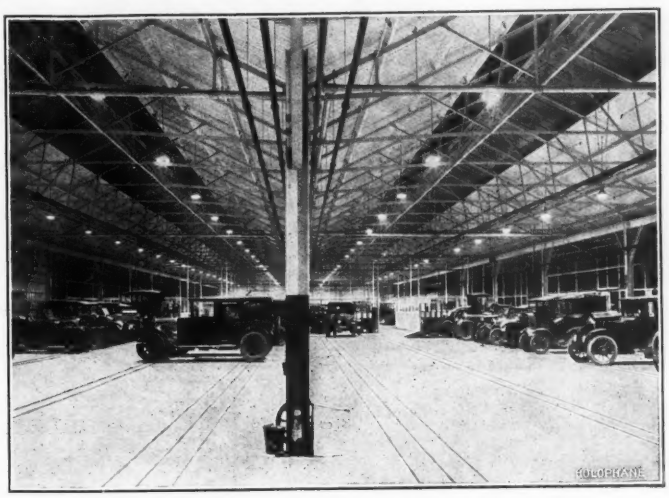
Both installations furnish examples of high-power lamps mounted as high as possible and permitting the use of a wide spacing. There can be no question of the importance of good lighting conditions in this form of work, and, owing to the fact that the floor is fully occupied by bulky machinery or apparatus, it is obviously desirable that units should be mounted well up out of the direct range of vision.

The Lighting of a Large Motor Car Works

Motor-car manufacturing concerns, many of which are typical examples of mass production, need specially good lighting in view of the skilled nature of the work. The varied operations demand different forms of lighting, but the repair and general inspection departments usually call for general lighting from overhead units, as the whole of the large area must be left free for cars to move about. The accompanying illustration shows a section of the repair shops of the Standard Motor Company. The width of these bays is about 40 feet, and some of the shops are as long as 400 feet. Units comprising 300-watt gasfilled lamps in Holophane intensive-type reflectors are mounted at a height of 16 feet, and the illumination furnished is approximately 7 foot-candles. Overhead lighting by Holophane industrial units is also provided in the R.A.F. Motor Transport Department at Henlow.

Other illustrations of Holophane installations before us include the views of the erecting and aero-engine shops of Messrs. Armstrong, Siddeley & Co., where similar methods are employed, though in this case the height of suspension is as high as 27 feet. The illumination was of the order of 4.5 foot-candles.

The special industrial lighting issue of *Holophane Illumination*, from which these pictures are reproduced, also contains some good examples of local lighting. Typical instances are afforded by the works of the True Form factory and works of Messrs. W. Barrett & Co., both in Northampton, the former being a particularly good example of local lighting with aluminium-covered Holophane reflectors.



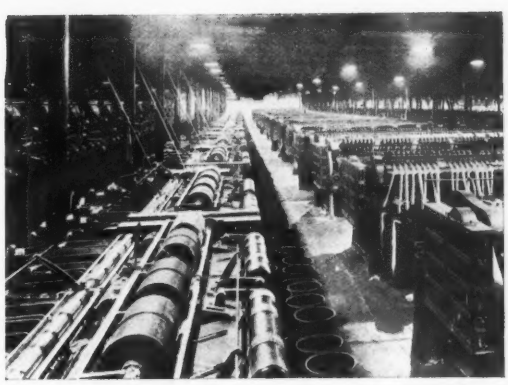
A view of Standard Motor Co.'s Repair Shop (night photograph).

Some G.E.C. Installations in India

The three pictures below form part of a series furnished by the General Electric Co. Ltd. Figs. 1 and 2, showing the lighting of an Indian jute factory, being used to illustrate the G.E.C. campaign for better industrial lighting. Such a factory may be taken as a typical instance of a case where complex machinery has to be lighted and where much of the material is dark in texture; both high illumination and good diffusion are therefore needed.

FIG. 3.—Howrah Pontoon Bridge, Calcutta, illuminated by G.E.C. "Wembley" Lanterns.

The third illustration, a picture of the Howrah Pontoon Bridge, Calcutta, is not, strictly speaking, an example of industrial lighting, but is interesting as another illustration of the progress of modern methods of lighting in India. The lighting is being effected with G.E.C. Wembley lanterns, which have figured recently in many important public lighting installations in this country.



FIGS. 1 and 2.—Showing Industrial Lighting in an Indian Jute Factory.

Two features of such factories are the intricate nature of the machinery and the large number of inclined or vertical surfaces that require illumination. Good diffusion of light is therefore essential.

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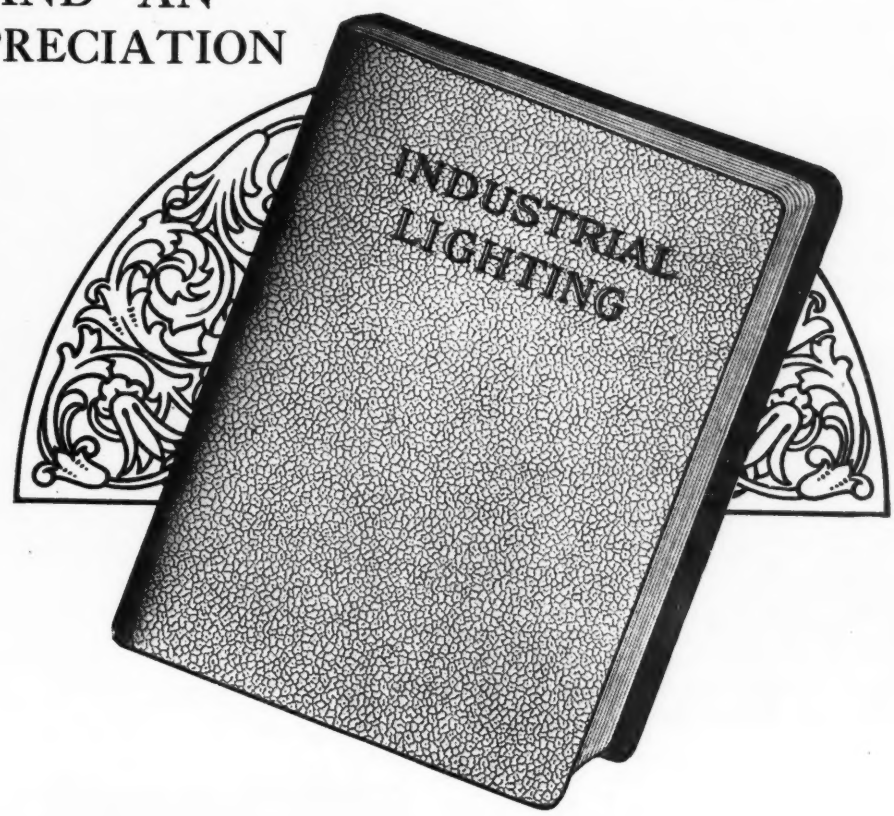

THIS leather bound treatise will be presented to all bona fide applicants interested in the betterment of factory and workshop lighting.

Its chapters deal with Lighting Fundamentals—Measurement of Light—Economics of Lighting - How to Test a Lighting Installation — Planning the Installation — Maintenance — Improving an Installation — Illumination Data, Reference Tables, etc.

The Publication has been somewhat delayed in order to include data on the new lamp dimensions, but all previous requests have been acknowledged and copies will be sent as soon as available.

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Efficient Lighting in the Factory

THE two accompanying illustrations, which are obtained from untouched photographs of two installations utilizing B.T.H. "Glassteel" diffusers, illustrate an interesting problem in factory lighting—how to obtain the desired concentration of light and at the same time furnish a diffusing effect.

In order to provide economically the high intensity of illumination on the working plane necessary in a modern factory reflectors of a distinctly " concentrating " type are desirable. At the same time, both with a view to promoting uniformity of illumination and also in order to soften shadows and eliminate glare, efficient screening of the actual filament is often desirable.

FIG. 1.—Confectionery Works of Messrs. H. Vincent Ltd., Hunnington.

The B.T.H. " Glassteel " reflector meets this requirement by combining the efficiency of the familiar B.T.H. " Mazdalux " reflector with the diffusing properties of an opal enclosing globe. It consists of an opaque metal reflector supporting a large diffusing globe which entirely conceals the lamp.

FIG. 2.—Part of the Sterling Telephone Co.'s Works, Dagenham.

These installations are typical of many arranged under the supervision of the lighting department of the British Thomson-Houston Co. Ltd., who are always prepared to advise on lighting problems without charge or obligation.

The Importance of " Angle of Cut-off "

The two illustrations in the next column, for which we are indebted to Messrs. Veritys Ltd, again illustrate the modern system of overhead lighting with scientifically designed reflectors, Fig. 1 showing the appearance of a large engineering workshop by daylight and Fig. 2 the same shop illuminated by artificial light. The great advantage of having a clear view of the shop, with units arranged well up out of the direct range of vision, is manifest. The general appearance of the " Maxlume " is shown in Fig. 3.

In the design of such reflectors great importance attaches to the " angle of cut-off." The contour is such that the filament is screened from view and the light is usefully directed downwards. With the angle of

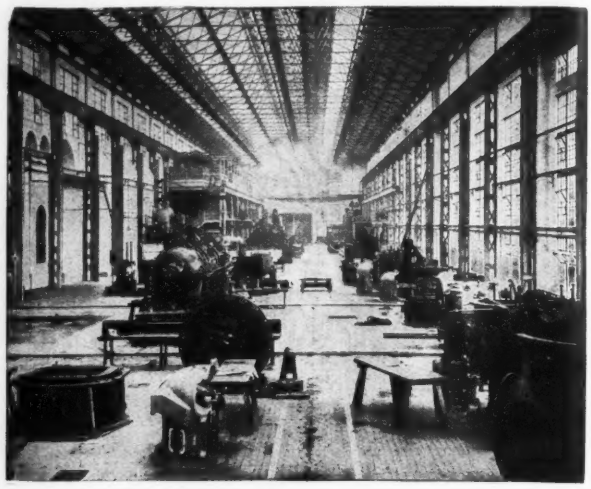


FIG. 1.—A large Engineering Shop illuminated by " Maxlume " Reflectors. Photograph by daylight.

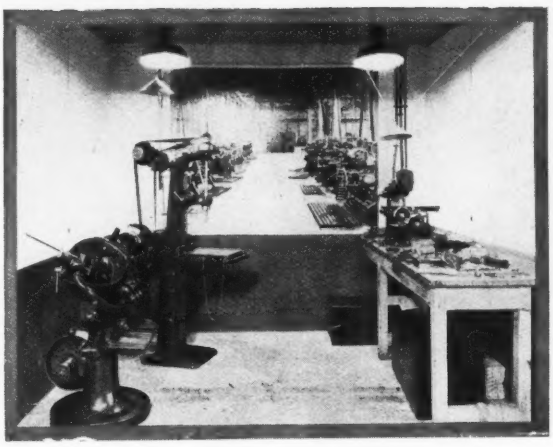
cut-off at 20°, adopted in standard industrial reflectors of the present day, glare is reduced to a minimum, for when the units are mounted at the usual high level for general lighting it is scarcely possible for direct light to

FIG. 2.—The same Engineering Shop photographed at night by the light of the lamps installed in " Maxlume " Reflectors. An untouched photograph.

enter the eye at angles less than 30°. Naturally, when lamps having internally frosted, white-sprayed, or opal bulbs are adopted, the possibility of glare is still further diminished.

FIG. 3.—General appearance of " Maxlume " Industrial Reflector.

The Lighting Service Bureau



The above is a view of the factory lighting cubicle at the Bureau, which has been specially equipped with machine tools and workbench, to enable convincing industrial lighting demonstrations to be made in a realisiic atmosphere.

Obsolete and modern lighting systems are incorporated, enabling direct comparisons to be effected in the correct surroundings.

Lectures on any branch of electric lighting can be arranged by request.

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Issued by the Electric Lamp Manufacturers' Association.

A Visit to the New Works of The Benjamin Electric Ltd. at Tottenham

A PLEASANT event on August 30th was the official opening of the new works of the Benjamin Electric Ltd., which was attended by a representative gathering of the press. After the party, numbering about 60, had made a complete tour of the works, they were entertained to luncheon at Frascati's Restaurant, when Mr. Guy Campbell, the managing director, presided. Mr. Campbell sketched the history of the Company's activities in this country and gave a brief summary of its aims and policy. We are betraying no secret in mentioning that the exceedingly rapid development of the Benjamin Electric Ltd. during the last 20 years is due very largely to his enterprise and energy. The story of the development of Benjamin Electric Ltd. in this country is a most interesting one. It is now just 20 years since the Company was initiated. Its history falls into two equal periods—the 10 years up to 1918, during which work was conducted at Rosebery Avenue, and the subsequent 10 years, during which the present site at Tottenham has been occupied. The original move to Tottenham was a necessary consequence of continually extending work, but subsequent progress has been equally rapid, with the result that the space at Tottenham has been again increased at intervals. A further six shops were added in 1925; but only two years later, in 1927, it became imperative to build a complete new factory, which doubles the floor space previously held.

The leading feature of the present factory, which is designed on modern lines, is the allocation of all production processes to a single floor, conveniently surveyed from the works manager's office, which is slightly raised and overlooks the whole area. A second story is used for general and executive offices. Another feature of the design is the excellent access of daylight.

FIG. 1.—Heavy Presses for the Production of "One-piece" R.L.M. Reflectors, Motor-Car Radiator Shutters, etc.

The equipment of the factory has likewise developed. The dominant item is, perhaps, the battery of huge British-made Taylor & Challen presses, which are used for the shaping of reflectors. The manufacture

FIG. 2.—The R.L.M. Reflector Store.

FIG. 3.—The Toolmaking Shop.

FIG. 4.—The Polishing Shop.

of these modern metal reflectors, the exact contour of which is of great importance from the illuminating engineering standpoint, is a most complex process. Successive pressing is necessary to attain the final shape and annealing is frequently needed between the operations. The culminating achievement was doubtless the manufacture of the large "one-piece" reflectors, which are constructed from a single piece of steel, thus eliminating the seam between skirt and neck. We understand that this reflector passes through no less than 17 different operations!

The Company has also an exceptional tool-making department, and in this case the "tools" involve something beyond what is ordinarily needed in a factory.

Visitors passed in succession through the production office, whence all orders are issued, the production inspection department, which ensures continuity of a high standard of work, the tool-making and tool store, the spinning section, the machine shop, the press shop, the final inspection department, etc. Whilst light, medium and heavy presses play an important part in the manufacture of most Benjamin products, a considerable amount of spinning work is done, spinnings up to 4 feet in diameter being handled. Every article manufactured passes through three stages of inspection, and it may be mentioned that whilst a great deal of the work is naturally highly standardized the firm also lays itself out for the design and execution of many special articles, such as are called for in illuminating engineering.

Another interesting department is the assembly shop, where small fittings and accessories are collected. The stores occupy a considerable area and are exceptionally complete. We understand that whilst the works are organized for the production of 20,000 to 25,000 reflectors a week (apart from special contracts and specialities), about 80,000 to 100,000 are kept in store!

Hitherto, we have referred mainly to the manufacture of Benjamin reflectors, the item with which our readers are naturally most interested. But the firm is responsible for other specialities, amongst which the well-known Boyce Moto Meter, electric horns for motor-cars, and wireless valve-holders may be mentioned. It was stated that over a million and a half of these special valve-holders have been manufactured since their introduction two years ago.

Naturally, Benjamin reflectors are used throughout for the overhead lighting of the factory and a standard of 10 foot-candles is maintained, whilst in the office a value of 8 foot-candles is maintained.

A feature of the new factory is the testing and research laboratory. The work of the Company has always necessitated special experiment, much of which, owing to lack of space, was formerly carried on by Commander Haydn T. Harrison, in his reseach laboratory at Canterbury. Now the contents of the Canterbury laboratory have been transferred to Tottenham, where a fully equipped testing department is available. The photometric room, now in course of development, accommodates a photometer bench 40 feet long, enabling candle-powers up to 250,000 to be measured. This room also serves for the calibration of the Benjamin Light-meter. Adjacent to the laboratory is an open flat surface admirably adapted for experiments on floodlighting units, etc. This area is open to the sky on three sides, and the fact of its being possible to judge the effect of beams on walls of adjacent buildings is a distinct advantage. Other open spaces at ground level afford facilities for tests on street lamps, etc.

The whole of the laboratories, test room, and research work are under the supervision of Commander Haydn T. Harrison, M.I.E.E., who has for many years acted as chief technical adviser to the Company and is now devoting his time to their work.

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The Provincial Lighting Service Bureau, Scotland

By H. E. HUGHES

ONE does not expect the Scottish people, with their characteristic caution, to grasp a new opportunity instantly, but the Scottish Electric Lighting Service Bureau, which represents an entirely new idea in the country, has quickly succeeded in arousing interest in its work, and has obtained much support in an endeavour to bring better lighting to Scotland. For nearly three years a lecture service has been in force, and demonstrations of correct lighting principles have been given to all visitors at No. 20, Trongate, Glasgow, where the Bureau is situated, the idea behind the movement being the propagation of the desire for good lighting.

The Bureau premises consist of demonstration and lecture rooms and offices, and these have been kindly lent to the organization by the Watching and Lighting Department of the Corporation of Glasgow, and Mr. S. B. Langlands, Chief Inspector of the Lighting Department, is chairman of the local Bureau Committee. Mr. Langlands has given freely of his time and assistance towards the furtherance of this progressive work. The Bureau has benefited considerably as the result of his interest, and incidentally under his department the whole standard of lighting of the city, particularly the lighting of streets, has continued to improve year after year, in keeping with the status of the second city in the Kingdom.

What of the commercial lighting of Glasgow? Can it be said that well-lighted shop windows do their silent selling here as in other cities? Also, are the shop interiors and offices using the modern methods advocated by lighting engineers? In answering these questions it should be stated that the commercial branch of lighting has received more attention by the Bureau staff than any other, with the possible exception of home lighting, and the results all round have been encouraging. Naturally, they are not sufficiently encouraging for the optimists, who would like to see darkness turned into light everywhere and now, rather than at some future time. In the shop windows on main streets there is excellent high-intensity lighting, which compares well with the standard of other cities, and the frequent use of coloured light and "stunt" lighting tells the story of what has been advocated as specially attractive features. There are, of course, here as elsewhere, many shopkeepers who are not yet converted, and they exhibit painful examples of glaring bare lamps or absence of after-hour lighting, to their own undoing. Many groups of shopkeepers and members of trade associations have attended lectures at the Bureau on the subject of shop lighting, and the adoption of modern systems of general lighting for shop interiors and top lighting for the windows testifies to what has been accomplished by the demonstration method.

In the matter of improvement of lighting in factories, and in industrial establishments generally, good spade work has been accomplished, and the result is that in many places obsolete local lighting has been replaced by modern general lighting, in which the standard dispersive reflector is employed. Though this movement has been rather slow, the advantages of the new system have been immediately realized when the new installation has been brought into use. It is regrettable that there is difficulty in obtaining from the management useful data showing increase in production due to the comparatively small cost of the improved lighting. Acknowledgment of all the other advantages is usually forthcoming, however, such as less spoilage of material, less trouble with workers' eyesight, fewer accidents, and general improved hygienic and working conditions.

Home lighting, with its innumerable problems, peculiar to different kinds of houses, with people of different tastes, has been dealt with at the Bureau by the same method of lectures and demonstrations. A small adjoining room has been adapted for use as dining-room, lounge, bedroom or kitchen, and the transformation from one setting to another takes place behind drawn curtains during the progress of a demonstration. Both furniture and lighting fittings are changed, and the room conforms to the description being given, a method which is very appealing and convincing to an audience. Judging by the number of instances one sees of coloured lighting in sitting-rooms and elsewhere in homes throughout the country, it is evident that the use of colour as a beautifier of interiors is becoming more and more appreciated. The Scottish Bureau has always made a strong point of the possibilities of colour lighting, and the advice which has been so often given has evidently been taken seriously by people who would make their homes more beautiful.

FIG. 1.—A View of the Lecture Theatre of the Provincial Lighting Service Bureau for Scotland.

All branches of the lighting art are dealt with at the Bureau, and the staff has to be prepared to advise on any point in connection with lighting and light control. The wiring of buildings is, of course, outside the scope of the work.

Over 3,200 people were directly reached by the activity during the second year of operation, and the figure will be similar for the present year. In addition to the usual lectures, a complete illumination course has been given during each of the past lighting seasons, and another is arranged for the coming autumn. By means of such a course of lectures, employees in the trade and other interested parties are kept in close touch with the principles and the latest practice in lighting. Lecturers from other centres deal with various of the special subjects covered, and in this way advantage is taken of hearing the story from another angle at each of the lectures in the course.

Not the least important phase of the work is the annual or semi-annual lecture given to different educational groups. H.M. factory inspectors, students from the Royal Technical College and College of Domestic

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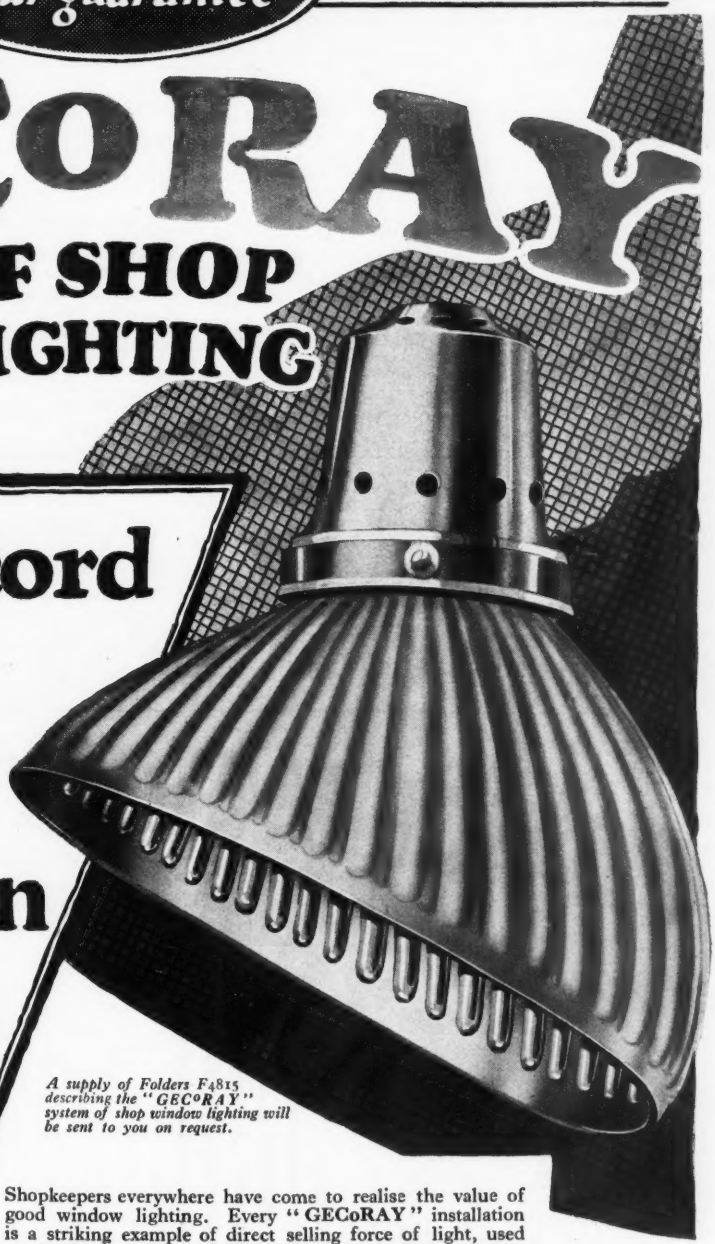

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Science come under this category, and also various groups of Rover Scouts and Guides. Lectures to Rotary Clubs have been a feature of the activity, about a dozen clubs throughout Scotland having received the message of " modern illumination."

At the present time there is considerable activity in connection with the campaign for better lighting in factories, and the Bureau staff is busy with this, and later in the year there will be many factory-lighting demonstrations and lectures to be given. Anything connected with illumination receives the active support of the staff, and there are always campaigns and similar activities being planned, and later carried out to further the good work. Many lectures are given outside the Glasgow area, and towns as far apart as Aberdeen and Dumfries are reached by this form of activity.

In conclusion, gratification must be expressed for generous support from the many subscribers to the Bureau funds. Particular satisfaction is felt that all the original subscribers have continued this practical method of showing their continued interest, and this is very encouraging to members of the committee, who have given of their time freely. The work is evidently bearing good fruit, and the early reluctance on the part of the public to make free use of the Bureau seems to have been largely overcome. Perhaps the publication of a well-illustrated and attractive brochure during the present year has had the desirable effect of bringing lighting service more prominently to the fore.

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Daylight Illumination

The September issue of *Holophane Illumination* deals entirely with problems related to daylight, and is a particularly interesting number. An introductory article points out that in providing access of daylight, as in most other lighting problems, a compromise is necessary. Abundant access of sunlight is now considered desirable in view of its general tonic action on health; but, as illuminating engineers are aware, direct sunlight is also capable of causing considerable glare, and the use of light blinds is desirable if there is danger of direct sunlight being received on the working area. This point is further emphasized in an instructive contribution by Dr. James Kerr, reviewing the case for admission of ultra-violet light and the beneficial effects ascribed to exposure to sunlight. Dr. S. English, in his article on " Sunlight Indoors," enters into the technical problems involved in the production of special window glass, transparent to ultra-violet light. It is perhaps not generally known that unless care is exercised in manufacture this quality of permeability to ultra-violet rays is apt to depreciate. By suitable selection and treatment of materials, however, a glass can be obtained which has practically unchangeable characteristics. This leads to a detailed description of " Holviglass," the latest ultra-violet transmitting glass which Holophane Ltd. have only recently introduced. Some data furnished by Professor Turner, of Sheffield University, illustrate the high degree of transparency to ultra-violet energy secured. Good ultra-violet transmitting glass is similar in appearance to ordinary glass, but as great care has to be exercised in its preparation mass-production methods cannot be applied. A description is included of the Wilson Memorial Hospital, Mitcham, in which Holviglass has been installed.

Other items include a contribution by Mr. J. Douglas Scott, A.R.I.B.A., on legal problems involved in the easement of light and a description of the Holophane " Correctalite " unit, which furnishes artificial daylight.

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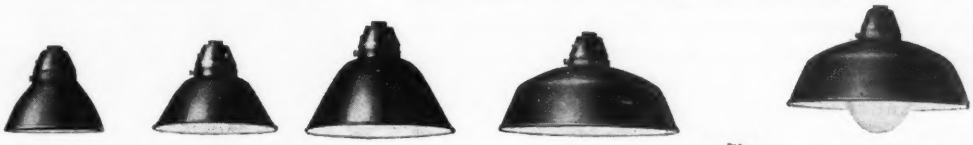
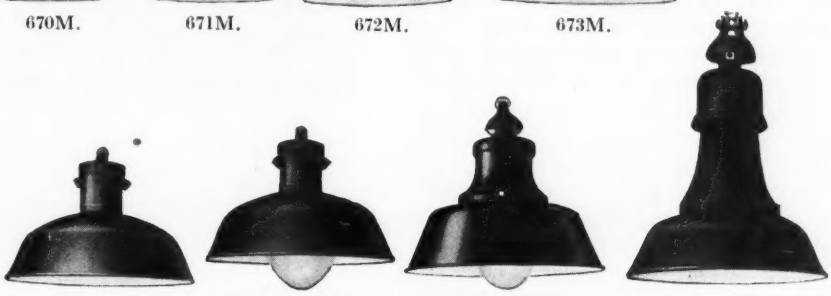


670M. 671M. 672M. 673M. 673GLM.

Typical examples of Kandem Reflector fittings with focussing lampholders, by means of which the dispersive angle can be varied between 150° and 180°



No. 609. No. 609/GL. No. 608. No. 607.

Examples of Kandem watertight fittings with white glazed porcelain canopy, with vitreous enamelled reflector and protecting well glass for lamp.

No. 633M.

No. 632M.

Examples of Kandem Reflector fittings for local illumination.

No. 565PL. No. 564M.

ASSEMBLY SHOP ILLUMINATED BY KANDEM REFLECTOR FITTINGS

The extraordinarily varied questions which arise in connection with the up-to-date illumination of industrial establishments are answered in a striking and complete manner in the October issue of our House Journal—"The Kandem Quarterly Review." In this not only are examples of good and bad illumination of industrial premises given, but also the most usual faults, such as glare, reflection from glazed surfaces, deep shadows, etc., are explained and ways and means of preventing them illustrated. This journal will be forwarded free of charge to all those interested.

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Gas for Factory Lighting

THE accompanying illustrations are from untouched photographs taken at night-time in a gaslighted workshop in London.

Fig. 1 is a general view showing the lighting of the three double benches, which run almost the entire length of the building. In this shop work is done not only on the benches but on the floor space between the benches. Adequate illumination, free from shadows, is therefore also required on the floor as well as on the benches. Round three sides of the shop there are wall benches. On the fourth side there are a number of power-driven machines for general machine work.

Main Bench Lighting.—The general lighting of the shop, as well as the lighting of the three central benches, is by three rows of eleven Sugg three-light "Swanley" lamps with superheaters and enamelled-steel reflecting shades. They consume about 7½ cubic feet feet of gas per hour and give a light of approximately 240 candle-power. The lamps are suspended so that the sources of light are 10 feet above floor level and 7 feet 3 inches about bench level. They are centrally disposed along each double bench, and are 14 feet apart measured along the benches and 17 feet apart measured from row to row. Three additional "Swanley" lamps are used for illuminating respectively the two doorways leading to the shop and the engine room housing the 45 b.h.p. gas engine which drives the machines already referred to.

Measurements made of the illumination along the front edge of one of the benches, at 6-inch intervals, showed that the average illumination was 5.6 foot-candles, the maximum was 5.8 foot-candles, and the minimum 5.4 foot-candles.

The illumination on the jaws of three vices on the benches was as follows:—

No. 1 Vice	... ...	7.1 foot-candles.
No. 2 Vice	... ...	5.8 ,,
No. 3 Vice	... ...	5.9 ,,

As assembly work is carried out on the floor space between the benches, measurements were taken along a line midway between two of them, at intervals of three feet, and the results are tabulated below:—

Fig. 1.

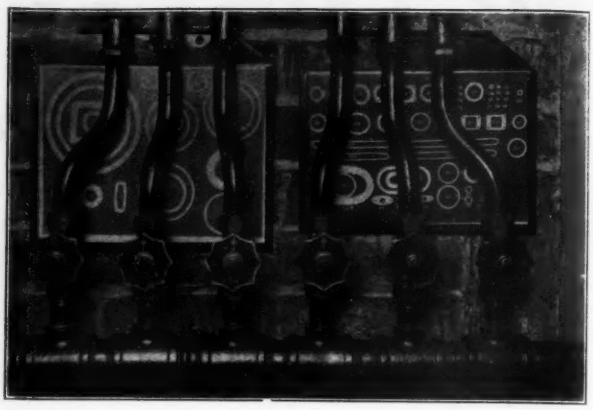


Fig. 2.

Position.	Illumination.
Datum	4.0 foot-candles.
3 ft. from datum.	4.15 ,,
6 ft. ,,	3.9 ,,
9 ft. ,,	4.4 ,,
12 ft. ,,	4.4 ,,
15 ft. ,,	4.6 ,,
18 ft. ,,	4.15 ,,
21 ft. ,,	3.7 ,,
24 ft. ,,	3.3 ,,
27 ft. ,,	4.6 ,,

The average illumination was therefore 4.1 foot-candles and, as will be seen, the maximum 4.6 and the minimum 3.3 foot-candles.

Distance Control.—The lighting fittings are arranged, for lighting and extinguishing, into seven sections, each consisting of five lamps. Six sections consist of the five lamps at each end of the three rows. These are turned on and off by six control cocks placed in the foreman's office. (See Fig. 2.) The seventh control cock is placed near one of the entrances to the shop, and turns on and off the centre light of each row and the two lights over the entrances. The control system adopted is Sugg's patent distance-control device. The light in the engine room is turned on and off by means of an ordinary lever cock on the lamp itself.

Supervision from Foreman's Office.—As is the case in most modern shops, the foreman's office is situated in a position which commands a complete view of the shop. From his desk at night-time he has a particularly clear view even into the farthest corners, owing to the excellent illumination provided by the gas-lighting fittings, and to the fact that the brilliant sources of light are screened from his eyes by the reflecting shades.

Lighting of Wall Benches.—The wall benches (see Fig. 3) on three sides of the room are lighted by 46 1-light medium inverted burners with deep conical shades fixed 3 feet 6 inches above bench level and 5 feet 6 inches apart. Each burner consumes about 2½ cubic feet of gas per hour and gives a light of approximately 60 to 65 candles. The burners are so arranged that they give the maximum illumination on the bench vices and a very good illumination on the lengths of bench on each side of the vices.

FIG. 3.

Illumination measurements were taken along the edge of these benches and also upon the jaws of the vices. The measurements along the benches were taken at approximately 6-inch intervals, with the following results:—

POSITION.	ILLUMINATION.
Datum	8.3 foot-candles.
6 in. from datum.	8.1 ,,
12 in. ,,	7.7 ,,
18 in. ,,	7.5 ,,
24 in. ,,	8.75 ,,
30 in. ,,	9.6 ,,
36 in. ,,	8.7 ,,
Illumination on	
No. 1 Vice	9.6 ,,
No. 2 Vice	10.9 ,,

Machine Lighting.—The power-driven plant, consisting of drills and grinding, polishing and cutting machines of various types similar to those to be found in any engineering workshop, are arranged parallel with, and fairly close to, the fourth wall of the shop. They are provided with 21 special lighting units, each fixed on a universal swivel arm, which makes it possible for each machinist to adjust the position of the light to suit his own comfort and the class of work on which he is engaged. These arms are simple and strong contrivances, and can be moved easily about a centre both horizontally and vertically. They are locked into any desired position by a butterfly nut. Some of these lamps are used over large grindstones, where the fabric of the mantles might be damaged by flying material from the work. The bases of the conical reflectors are therefore closed in with patent wired glass discs, which prevent any pieces from reaching the mantles, and do not splinter if they become cracked by a particularly large piece of flying material from the grindstones.

The machines shown in Fig. 4 are grinding and polishing machines, and their lighting units are provided with these glass protectors.

Illumination tests were taken on the working surfaces of some of the machines. As already stated, the lighting units can be moved both horizontally and vertically. The tests were therefore made with the lights in the positions in which they had been left by the machinists, as it is assumed that these would be the positions which the experience of the workmen found to be the most suitable. Some of the results are as follows:—

POSITION.	ILLUMINATION.
Drilling Machine	10.7 foot-candles. 11.2 ,,
Small Grinding Machine...	20.8 ,,
Polishing Mop	12.1 ,,
Double Grinding Machine	9.7 ,, 10.2 ,,

Gangway Lighting.—A point to which careful consideration was given when arranging the lighting of this section of the shop was the illumination of the gangway in front of the machines, which is 20 feet wide and runs the whole length of the shop. Great care has always to be exercised in keeping gangways near high-speed machines as free as possible from obstructions which might cause men to stumble, and, where there are obstructions, to see that the lighting units are sufficiently powerful and so disposed that they cast little or no shadow.

All of the burners over the wall benches and on the machines are individually lighted.

The lights near the entrances to the shop, and those in the adjoining shops, are designed and disposed to give approximately equal illumination. Thus, workmen coming from one shop to another do not suffer from the eye discomfort which is sometimes experienced by passing from a poorly lighted shop into a well lighted one, or vice versa. In these latter cases temporary disability is caused by the necessity of rapid accommodation of the eye to the sudden change in the intensity of the illumination.

Economy of Control System.—From the above description it will be seen that any section of the shop can be lighted up or turned out as desired, so that should the men engaged on one class of work only be doing overtime there is no necessity to light up the whole of the lamps in the building and waste gas. The three centre lights in the main rows and the two lights near the entrances to the shop give sufficient general illumination throughout the building to enable men to walk safely along the gangways which are not in use (if the necessity arises), and to enable the night watchman to go his rounds.

It is interesting to note that when the shop was designed the architect paid due attention also to the daylight illumination—a point often neglected.

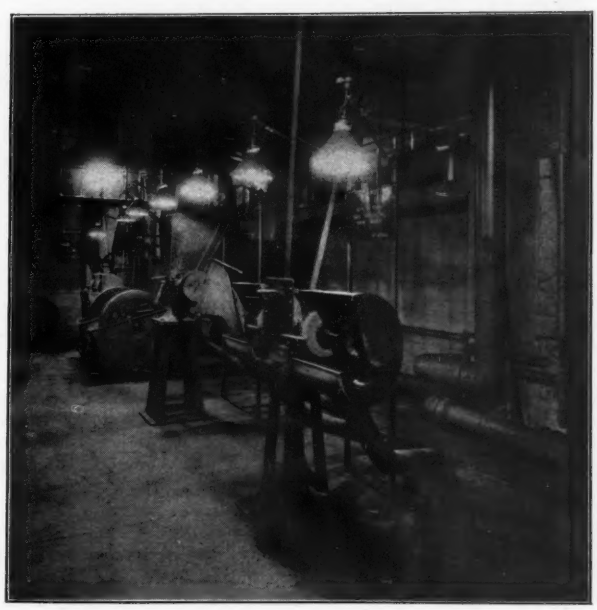


FIG. 4.

TRADE NOTES & ANNOUNCEMENTS

MAZDA LAMP ADVERTISING CAMPAIGN, 1928-29.

We understand that the Mazda lamp campaign for the coming season is to surpass all previous efforts. Press advertising on an extensive scale is already being initiated, and, as usual, numerous attractive posters, window displays and leaflets have been prepared. The showcard here illustrated, " Beauty Enshrined by Light "), is an effective example, measuring 22½ in. high and 16 in. wide, and is provided with a hanger and strut at the back. Other items include an arresting window display arranged in the form of three panels as a folding screen, the overall dimensions of which, when fully extended, are 47 in. high and 40 in. wide, with a depth from back to front of 5 in. This features in the centre the familiar "Mazda Girl" in the act of pulling the switch of a table lamp, to the delight of the small but appreciative child whom she is carrying. The table lamp itself yields a soft light, furnished by a Pearl Mazda lamp at the back, and controlled by a thermal flasher; a second lamp illuminates the lettering on the lower portion of the centre panel. Yet another item is a showcard dealing with Mazda automobile lamps.

This season's Mazda lamp catalogue is one of the most comprehensive yet published, and consists of 24 pages, wherein all types and sizes of lamps are portrayed. This is supplemented by an array of leaflets covering lamps for special purposes, and finally by a striking folder entitled " Selling Light," which is specially intended for the trade.

REDUCTION IN LAMP PRICES.

Similar advertising efforts are being made by other leading lamp makers, and their effect should be enhanced by the announcement, in a recent circular issued by the Electric Lamp Manufacturers' Association of Great Britain Ltd., of substantial reductions in the prices of lamps. These reductions apply to a wide variety of types, both vacuum and gasfilled, and, of course, to lamps supplied by all the firms associated with the above organization.

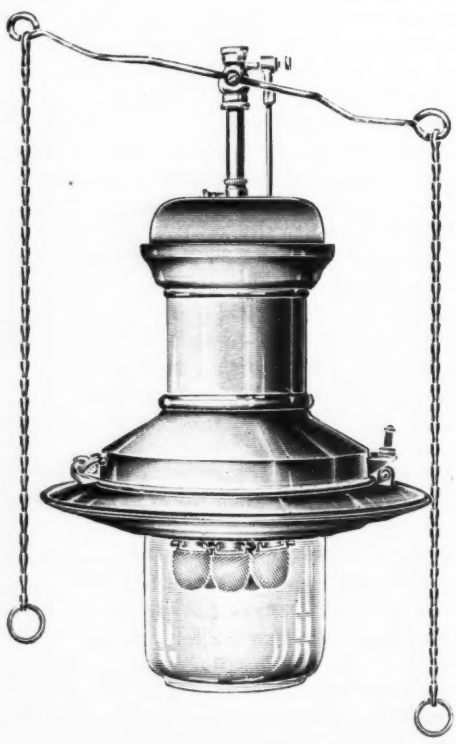
WELSBACH SPECIALITIES.

We are glad to record further progress at Welsbach House, described as " The House of a Thousand and One Lighting and Heating Appliances." As readers are aware, the Welsbach Light Co. Ltd. is concerned with oil, gas and electric appliances. We understand that an imposing new electrical showroom is on the point of completion.

A pleasing Flakestone Semi-indirect Bowl, suitable either for gas or electric light.

This year all the familiar lighting units, and some new ones, will be on view. The " Eddystone " burner, fitted with an all-magnesia nozzle, continues to be one of the most popular. The " Calshott " burner has been further improved by the inclusion of a new diffusing nozzle, which has a perforated refractory disc inside; this is not only conducive to silent burning but dispenses with the corrodible steel gauge. We illustrate the new " Calshott " 5-burner inside lamp, which is likely to prove increasingly popular for factory, restaurant, hotel and shop lighting. Another burner is the " Tuskar," which is being constructed in a simpler and neater design, and is now available at a somewhat lower price.

The fittings cover a very wide range, but we have always regarded the semi-indirect decorative and diffusing bowls as one of the most distinctive lines of this firm. We are illustrating one pleasing form, but visitors will find many from which to select; it should be borne in mind that these bowls are equally applicable to gas and electric lighting.



The new " Calshott " Indoor Superheater 5-Light Lamp.

British made

"MAXLUME" Regd.

On Reflection—
—the best

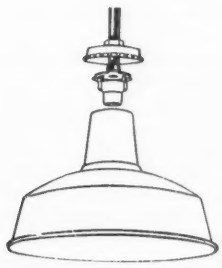
INDUSTRIAL & COMMERCIAL LIGHTING EQUIPMENT

DEEP ANTI-GLARE "H.O." (Home Office) REFLECTORS

Designed to the recommendations of the Departmental Home Office Committee to avoid glare and with 20 degree angle of cut-off between filament and edge of reflector. These H.O. type Reflectors were first catalogued by us in 1922, and many thousands are in use. **They are complete with Porcelain Lampholders which have Enclosed Shock-proof Terminals instead of the usual exposed types.** PATENT APPLIED FOR.

DELIVERY FROM STOCK. CARRIAGE PAID.

Illustrating Reflector pushed up the conduit for wiring or inspection.



The Reflector also is removable from below for cleaning, replacement or wiring up.

Note how any rod acting as lever will undo the top casting for wiring, etc., by means of the Special Peg

VERITY'S LIMITED

31, KING ST., COVENT GARDEN
LONDON W.C.1

There are no screws, rivets or screwed rods used in holding the reflector to the top. They cannot possibly fall down. There are no screws, screwed rods or moving parts to perish. They are rigid when fixed and will not vibrate in the wind. All types are ventilated, easy to wire, and Reflectors are removable for cleaning, and can be fixed or removed after wiring is completed; the only Reflector having these important features.

And at Manchester, Birmingham, Glasgow, Leeds, Liverpool, Bristol, Newcastle, Nottingham, Swansea, Dublin

PLUME, VICTORIA AND ARROL WORKS, ASTON, BIRMINGHAM

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FURTHER ELECTRIC LAMP PUBLICITY.

Amongst other examples of the season's propaganda by leading electric lamp makers we may mention a pleasing window display designed by Philips Lamps Ltd., and a well-executed price list under the title "Stock Philips Lamps—and See!" There are also numerous leaflets featuring such specialities as the "Duo-Savelite," automobile and other lamps, whilst the showcard is devoted to what is perhaps the most noteworthy of all—the Argenta lamp. This literature will be furnished on request to all traders, but this forms only a part of the comprehensive publicity scheme of Messrs. Philips Lamps Ltd., which will include extensive advertising in the daily and technical press, making an appeal both to the householder and to large industrial users throughout the country.

A feature of the Cryselco sales campaign is the showcard illustrating Cryselco Opal Lamps ("Radiance Without Glare"), whilst the familiar Colonel Chris Elco figures in an attractive cut-out. The current catalogue of Cryselco lamps is attractively got up. A new feature is the introduction of gas-filled daylight blue automobile headlights, which, we understand, are in great demand. Another readable item is the leaflet entitled "Night Lights," which is attractively executed in brown and green, and contains some telling illustrations. Finally, we may mention that the substantial reductions that are now being made in lamp prices also apply to the Cryselco opal lamps.

Other seasonable leaflets include those of Metro-Vick Supplies Ltd., The latest list of Met-Vick Cosmos lamps is conveniently assembled, and has a telling cover in orange and red. Another effort by the same firm takes the form of an imitation "Extra Special" newspaper placard, with a design in green and purple, drawing attention to the reduction in price of Cosmos lamps.

LIGHTING FOR GAMES AND SPORTS.

The current issue of the *Kandem Quarterly Review* (July, 1928) is quite up to the standard of its predecessors. The chief item is an illustrated discussion of the lighting for games and sports. Such problems as the lighting of racing tracks, tennis courts, football grounds, swimming baths, etc., are dealt with, and the different requirements in these various cases are pointed out. Another note deals with the Reflection and Transmission of Light, and there is a descriptive account of the Kandem slot meters.

We have also received from Messrs. Korting & Mathiesen Electrical Ltd., who are responsible for the above publication, some lists illustrating Kandem daylight fittings and "one-piece units." The latter are available in a variety of forms, and the quality of light furnished by the former is regarded as conducive to relief of eyestrain, besides improved appearance of colours. The one-piece units are executed in diffusing glass, and the designs are distinctly original. An effective illustration showing their use in a drapery establishment is included. An illustration shows another special item, the "ellipsoscope" for blue printing.

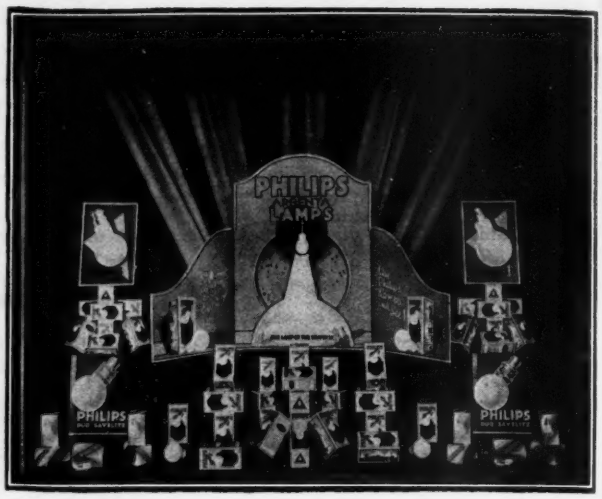
HARCOURT FITTINGS.

Messrs. Harcourts Ltd., a subsidiary company of Metro-Vick Supplies Ltd., whose premises have been recently extended, advise us that in spite of this extra accommodation they are fully occupied. Recent orders include special fittings for the Theatre Royal, Bolton; St. Joseph's Church, Heywood, Lancs; St. Joseph's College, Upholland, Lancs; Empire Theatre, Leicester Square, London; Rialto Cinema, Coventry Street, London; and fittings for the Cutlers' Hall, Sheffield.

Harcourt fittings, which have gained a reputation among the leading architects of the country, are mainly designed by the well-known sculptor, Mr. Walter Gilbert, with his staff of assistants.

ERRATA.

By a clerical error the name of the Company responsible for the "Duplex-a-lite" fittings referred to in our last issue (p. xvi) was incorrectly stated. We take this opportunity of correcting this error and of stating that these specialities are furnished by The Miller Co., of Meriden, Conn., U.S.A. We have since received from this firm an attractively got-up booklet dealing with hotel lighting. This contains a special plea for the modernizing of the lighting of old hotels. No doubt readers will sympathize with this plea, recalling some inns which preserve the "delightful old-world atmosphere," but unfortunately also perpetuate the inconvenient lighting of the past.



An Attractive Philips Display.

THE LONDON ELECTRICAL FIRM.

We had recently an opportunity of inspecting the works of the London Electrical Firm, in Croydon, and in our next issue we propose to include an illustrated description, referring to some of the most interesting things seen. As readers are aware, this firm has for many years been responsible for special raising and lowering gear, which is utilized both for industrial work and for operating lamps used for public lighting. The design incorporates various highly ingenious features, and these winches can be applied not only to electric lamps, but to high-pressure gas lamps—the latter a very severe test. Perhaps the other chief feature of this firm's work is the manufacture of searchlights in varied forms. We were particularly interested in some giant types now being made, with a barrel exceeding 8 feet in diameter. These are stated to be the largest search-lights ever constructed. We shall, however, have something further to say on these items in our next number.

ILLUMINATING GLASSWARE.

Two recent catalogues devoted respectively to Siemens Illuminating Glassware (Catalogue No. 196), and Silverstone Glassware, as listed by Metro-Vick Supplies Ltd., illustrate the great progress that has been made in this field during recent years. Both lists contain pleasing illustrations of diffusing glassware, and the series of ornamental bowls may be singled out for special notice. The Silverstone catalogue contains some attractive illustrations of decorative units executed in colour—a device which is becoming a regular feature in modern catalogues.

CONTRACTS CLOSED.

The following contracts are announced :—

SIEMENS ELECTRIC LAMPS AND SUPPLIES LTD. :—

General Post Office; for 12 months' supply of Siemens gasfilled, vacuum and traction lamps.

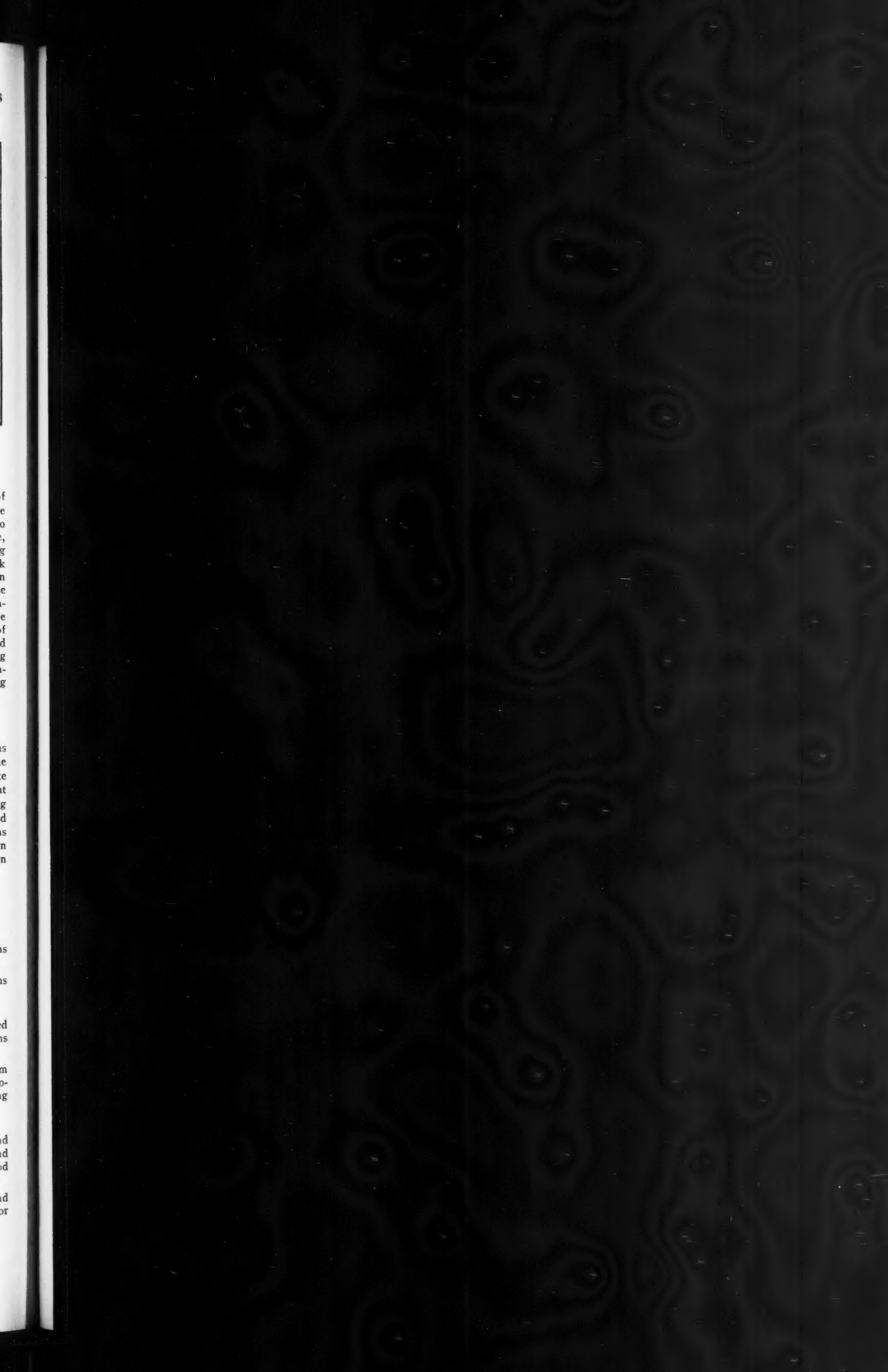
Southern Railway; for 12 months' supply of Siemens electric lamps.

METRO-VICK SUPPLIES LTD. :—

Post Office, Stores Department; for Cosmos gasfilled and vacuum tungsten lamps for period of 12 months commencing September 1st, 1928.

Southern Railways; for Cosmos gasfilled and vacuum metal-filament lamps, carbon-filament lamps and automobile lamps for period of 12 months commencing September 1st, 1928.

GENERAL ELECTRIC CO. LTD :—

Southern Railway; for supply of Osram vacuum and gasfilled lamps, including train-lighting lamps, and Robertson carbon-filament lamps over the period September 1st, 1928, to August 31st, 1929.

General Post Office; for supply of Osram vacuum and gasfilled lamps, and Robertson carbon-filament lamps for 12 months commencing September 1st, 1928.